Grain PRODUCTION and MARKETING

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CONTENTS

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GRAIN PRODUCTION AND MARKETING

By G. A. Collier, Chief, Market News and Services Division, Grain Branch, Production and Marketing Administration

Introduction and Distribution in the United States

Most of the grains now grown in the United States, except corn, were brought to this country by the early settlers. Corn was unknown to the civilized world before the discovery of America. When the first colonists settled in Virginia and Massachusetts they found the Indians growing corn and preparing various foods from it. The Indians taught the colonists how to grow and use this grain. Production of the bread grains—wheat and rye—and of the feed grains—corn, oats, barley, and grain sorghums—increased as the population grew, and with the new settlers it moved into the fertile valleys west of the Appalachian Mountains.

Wheat

The production of wheat,[1] our principal food grain, began on the Atlantic coast in the Virginia Colonies about 1618. The first great westward shift took place between 1783 and 1840 when the building of canals opened up transportation routes from the Atlantic coast to western New York, the eastern lake region, and the Ohio Valley. The crop in 1839, when the first census of agriculture was taken, totaled 85 million bushels. About half of it was produced east and half west of the Alleghany Mountains.

There was little change in the wheat area during the next 10 years. Between 1849 and 1859 another great shift occurred when Indiana, Illinois, and Wisconsin became the leading wheat-producing States. Large crops were also produced in California and Texas during this decade, for the first time. For the entire United States, production in 1859 amounted to a little more than 173 million bushels. In the decade ended with 1869, wheat production almost doubled in the States west of the Alleghany Mountains.

In the next 10 years the wheat crop moved steadily westward and extended into the Red River Valley. Dry-land wheat production also increased greatly in the far West. The expansion in the wheat area during this period resulted in part from the homesteading of public lands after the close of the Civil War. The development of more efficient harvesting and threshing machinery, including the binder and engine-driven threshers, also aided in this expansion.

Between 1879 and 1889 another important shift took place in the Wheat Belt. Acreage increased sharply in the spring-wheat-growing districts of the northern Great Plains, the hard-winter-wheat areas

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[1] Ball, C. R.; Leighty, C. E.; Stine, O. C.; and Baker, O. E. wheat production and marketing. U. S. Dept. of Agr. Yearbook 1921. Pp. 77–160.

of central Kansas, and in the dry-farming sections of the far West. A decline just as marked, however, occurred in the acreage of the upper Mississippi Valley.

Wheat production for the United States as a whole did not change materially during the decade ended with 1909, although the producing area shifted a little farther westward. Production increased sharply in Kansas, Nebraska, North Dakota, Montana, Idaho, and in eastern Washington and Oregon. During the next 10 years, however, wheat acreage expanded greatly as United States farmers responded to the World War I slogan of "Win the War with Food." Winter-wheat seeding increased from 29 million acres in 1909 to 51 million in 1919. During the same period spring-wheat seeding increased from 18 to 26 million acres. A record of 73 million acres of wheat was harvested in 1919 but unfavorable weather in June and July reduced yields and as a result production totaled only 945 million bushels. This quantity was about 60 million bushels short of the 1915 production of more than a billion bushels—the record up to that time.

Soon after the close of World War I demand for wheat fell off sharply. Prices at Minneapolis dropped from about $3.25 per bushel in 1920 to less than $1.25 per bushel in 1922. Farmers reduced their wheat acreage more than 10 million acres during the decade ended with 1929. Later during the depression years, prices dropped below 50 cents per bushel and seedings were further reduced. In the very dry year of 1934 production declined to about 525 million bushels.

In 1933 the Congress passed legislation providing for adjustments in the production of wheat and other grains. A gradual reduction in wheat acreage took place and by 1942 only 53 million acres were seeded. World War II created a need for greatly expanded supplies of foodstuffs and as a result wheat acreage in the United States was increased. Seedings in 1946 totaled nearly 72 million acres, from which a crop of 1,155 million bushels was produced (table 1).

As wheat production moved westward four fairly definite wheat-growing areas became established. The most important of these is the hard red winter wheat region, located primarily in the States of Nebraska, Kansas, Oklahoma, and Texas. The crop in these States in 1946 totaled more than 450 million bushels, or about 40 percent of the United States total. Hard red winter wheat is regarded primarily as a bread wheat because of its high protein or gluten content, which is necessary for high-quality bread.

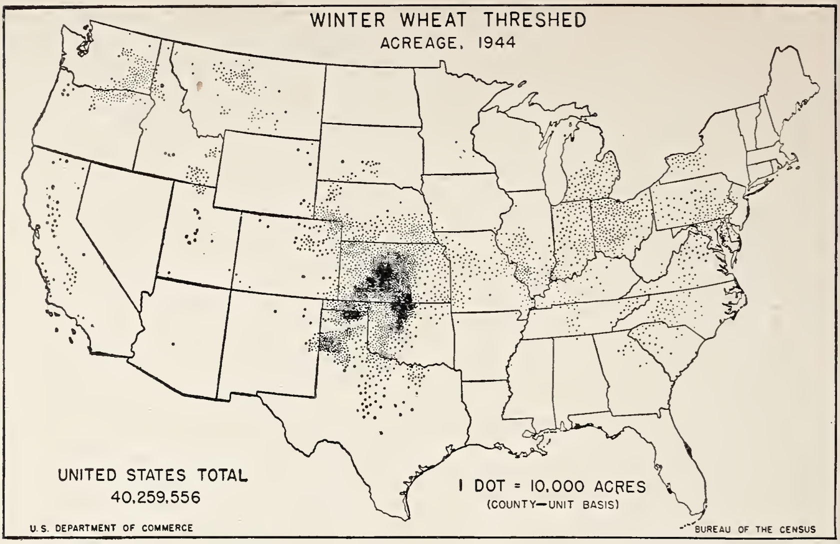
The next area of importance is the hard spring wheat region, located mainly in Minnesota, North Dakota, South Dakota, and Montana. Production in these States in 1946 amounted to nearly 250 million bushels, or about 20 percent of the total crop. There are two important classes of spring wheat—hard red spring from which the highest quality flours for bread making are milled, and durum wheat from which macaroni is made.

Another important wheat area is that comprising Missouri, Illinois, Indiana, Ohio, and the Eastern States which were important producers before the Civil War. Soft red winter wheat is the principal class grown in this area. In 1946 production of this class totaled nearly 200 million bushels, or 17 percent of the United States total. Flour made from soft winter wheat is generally considered best for pastries, but some of it is also used for bread making in the areas where this kind of wheat is produced.

Table 1.—*Wheat: Production in the United States, by selected States, for specified years, 1839 to 1946* [1]

State	1839	1849	1859	1869	1879	1889	1899	1909	1919	1929	1939	1946
	1,000 bu.	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*
New York	12, 286	13, 122	8, 681	12, 178	11, 588	8, 305	10, 413	6, 664	9, 136	3, 817	6, 544	5, 648
Pennsylvania	13, 213	15, 368	13, 042	19, 673	19, 462	21, 596	20, 633	21, 564	23, 454	17, 411	18, 083	19, 912
Ohio	16, 572	14, 487	15, 119	27, 882	46, 015	35, 559	50, 377	30, 664	58, 124	30, 290	37, 074	48, 522
Indiana	4, 049	6, 214	16, 848	27, 747	47, 285	37, 319	34, 986	33, 936	45, 208	25, 190	25, 654	29, 692
Illinois	3, 335	9, 415	23, 837	30, 128	51, 111	37, 389	19, 796	37, 831	70, 891	30, 151	38, 108	19, 553
Michigan	2, 157	4, 926	8, 336	16, 266	35, 533	24, 771	20, 535	16, 026	20, 412	13, 711	15, 804	22, 896
Wisconsin	212	4, 286	15, 657	25, 606	24, 885	11, 699	9, 005	2, 641	7, 328	1, 836	970	2, 263
Virginia and West Virginia	10, 110	11, 213	13, 131	9, 883	11, 828	11, 538	13, 234	10, 653	15, 194	9, 936	8, 994	9, 845
Kentucky	4, 803	2, 143	7, 395	5, 729	11, 356	10, 707	14, 265	8, 739	10, 375	2, 483	3, 659	4, 158
Tennessee	4, 570	1, 619	5, 459	6, 189	7, 331	8, 301	11, 924	6, 517	6, 362	2, 481	3, 886	3, 878
Minnesota		1	2, 187	18, 866	34, 601	52, 300	95, 279	57, 094	37, 616	19, 760	20, 342	27, 080
Iowa	155	1, 531	8, 449	29, 436	31, 154	8, 250	22, 769	8, 056	21, 592	7, 990	6, 568	3, 312
Missouri	1, 037	2, 982	4, 228	14, 316	24, 967	30, 114	23, 073	29, 837	65, 210	15, 117	30, 891	18, 780
North Dakota					1, 737	26, 403	59, 889	116, 782	61, 540	95, 574	69, 261	139, 824
South Dakota					1, 093	16, 541	41, 889	47, 060	31, 087	34, 045	17, 593	53, 197
Nebraska			148	2, 125	13, 847	10, 571	24, 925	47, 686	57, 844	53, 868	34, 676	90, 677
Kansas			194	2, 390	17, 324	30, 400	38, 778	77, 577	148, 476	148, 483	112, 414	216, 768
Oklahoma						30	20, 328	14, 008	65, 762	51, 184	58, 493	88, 262
Texas		42	1, 478	415	2, 568	4, 283	12, 266	2, 561	36, 427	44, 078	28, 096	62, 916
Montana				181	470	458	1, 900	6, 252	7, 800	40, 558	40, 350	62, 395
Idaho				76	541	1, 177	5, 340	10, 238	17, 877	28, 591	22, 323	34, 846
Colorado				258	1, 425	2, 845	5, 588	7, 224	18, 261	17, 332	11, 373	37, 080
Washington			86	217	1, 921	6, 345	21, 188	40, 920	41, 838	42, 589	44, 029	77, 965
Oregon		212	827	2, 341	7, 480	9, 297	14, 509	12, 457	19, 527	21, 527	15, 358	25, 168
California		17	5, 928	16, 677	29, 018	40, 869	36, 534	6, 203	16, 867	10, 958	10, 372	12, 597
All other States	12, 324	12, 908	22, 074	18, 995	24, 943	21, 307	29, 111	24, 189	31, 195	31, 689	27, 937	38, 481
U. S. total	84, 823	100, 486	173, 104	287, 575	459, 483	468, 374	658, 534	683, 379	945, 403	800, 649	708, 852	1, 155, 715

[1] Data from Bureau of the Census 1839–1939; estimates for 1946 from Bureau of Agricultural Economics, U. S. Department of Agriculture.



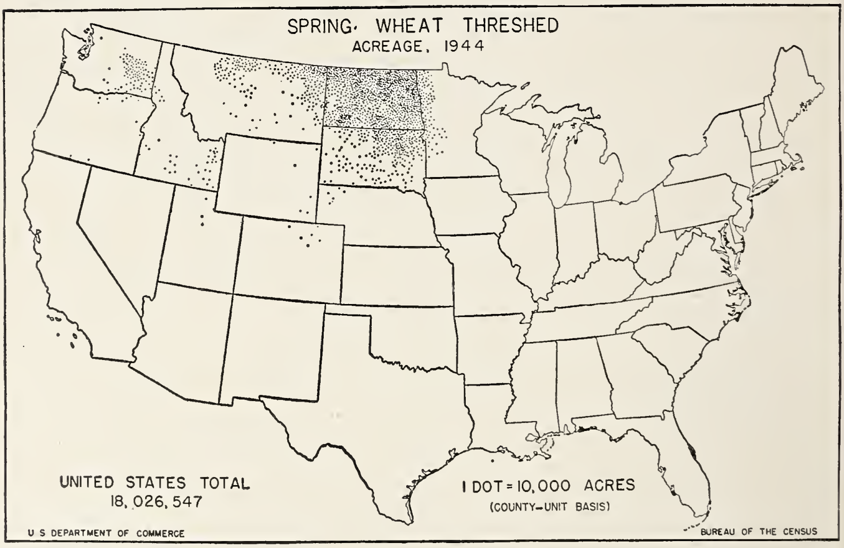


FIGURE 1.—These maps show the principal winter and spring wheat-producing areas in the United States, in 1944.

The fourth wheat-producing section is on the west coast, centered principally in Washington, Oregon, and Idaho, although considerable quantities are also grown in Utah and California. This western wheat region produces chiefly white wheat rather than red. Most varieties of this white wheat are classed as soft but some are classed as hard. Some are sown in the fall and some in the spring. The best qualities are used in the production of pastry flour for making cakes, pancakes, and crackers. These classes also are exported, used for feed, or blended with other types of wheat.

Corn

Corn was the earliest cultivated crop on the American farm.[2] The Indians taught the early colonists how to plant, cultivate, and use this important grain. The Virginia colonists planted 30 or 40 acres in 1609 and about 500 acres in 1614. The Massachusetts settlers planted their first corn in old Indian cornfields and fertilized it with a fish in each of the hills. Corn was the most important crop of the early settlers because suitable seed was readily available. It was the best yielding crop for newly cleared land and furnished food for both people and animals.

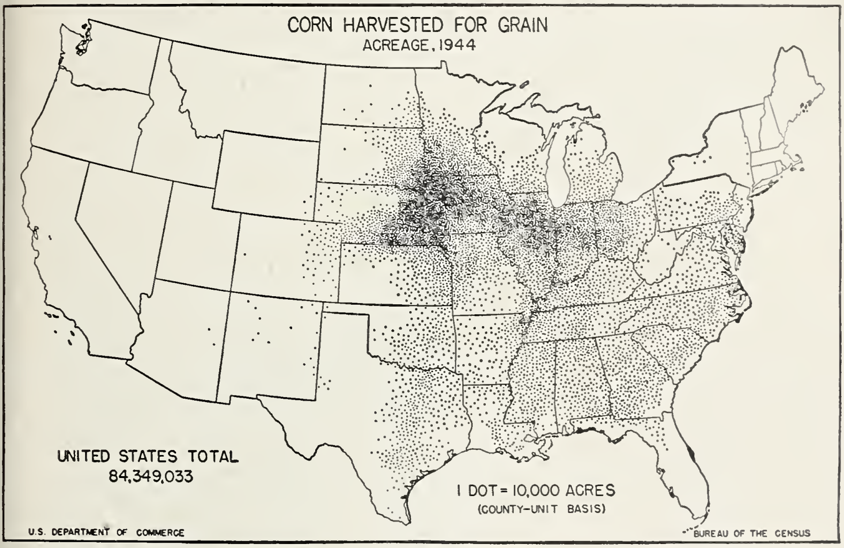


FIGURE 2.—Location and extent of the principal corn-producing areas in the United States in 1944.

The westward movement of corn production began immediately after the close of the Revolutionary War. By 1839 production in the United States had reached approximately 378 million bushels. Kentucky, Tennessee, Virginia, North Carolina, Ohio, Indiana, and Illinois were the principal producing States. Production more than doubled during the next 20 years as the result of a rapid settlement of the Prairie States. The Civil War retarded development during the next decade but rapid expansion occurred after the close of the war and production reached a billion bushels in 1870 (table 2).

The Corn Belt had become rather well defined by 1879 when production totaled more than 1¾ billion bushels. With the development of better yielding varieties, better methods of culture, and more favorable freight rates to eastern markets the corn area extended and production increased steadily, reaching a 2-billion-bushel crop by 1889.

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[2] LEIGHTY, C. E.; WARBURTON, C. W.; STINE, O. C.; and BAKER, O. E. THE CORN CROP. U. S. Dept. of Agr. Yearbook 1921. Pp. 161–226.

During the next 50 years there was a gradual expansion in corn production. A 3-billion-bushel crop was produced in 1912. Another peak was reached in 1948 when, as a result of the urgent need for food to feed the peoples of war-torn countries, American farmers produced slightly more than 3.6 billion bushels. These high levels of production resulted in part from the shift from open pollinated varieties to the higher yielding hybrid varieties. Yields per acre moved up from an average of 25 bushels in the 5-year period 1935–39, to more than 32 bushels in the period 1943–47. Information on hybrid corn may be obtained from Farmers' Bulletin 1744, The What and How of Hybrid Corn.

Oats

Of the major cereal crops of the United States, oats ranks third.[3] The culture of oats began on the Atlantic seaboard about 1630 and moved westward along with wheat after the close of the Revolutionary War. Acreage expanded rapidly from 1871 to 1890. the increase being

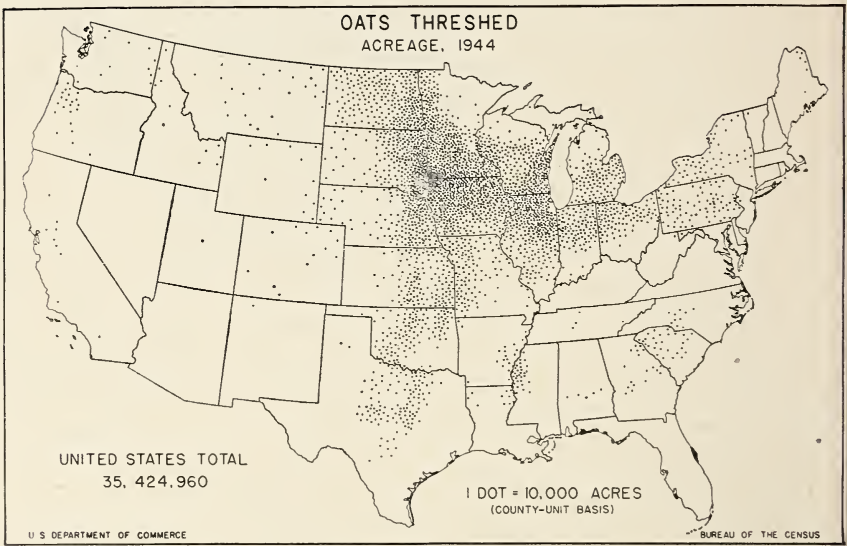

Figure 3.—The dots on this map indicate the principal oats-producing areas in the United States, in 1944.

principally in the Corn Belt States. Later the area of production moved into the upper Mississippi Valley. The first billion-bushel crop was produced in 1902. In 1945, during World War II, production reached a record of nearly 1.6 billion bushels.

Oats usually are not considered a cash crop. They are grown principally for feed or to complete a crop rotation system between corn and wheat or corn and grass. Economy in labor is an important factor

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[3] Ball, C. R.; Stanton, T. R.; Harlan, H. V.; Leighty, C. E.; Chambliss, C. E.; Dillman, A. C.; Stine, O. C.; Baker, O. E.; Juve, O. A.; and Spillman, W. J. OATS, BARLEY, RYE, RICE, GRAIN SORGHUMS, SEED FLAX, AND BUCKWHEAT. U. S. Dept. of Agr. Yearbook 1922. Pp. 469–568.

TABLE 2.—*Corn: Production in the United States, by selected States or regions, for specified years, 1839 to 1946* [1]

Region or State	1839	1849	1859	1869	1879	1889	1899	1909	1919	1929	1939	1946
	1,000 bu.	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*
New England	6, 993	10, 176	9, 165	7, 348	8, 376	6, 126	7, 808	8, 238	5, 598	1, 437	1, 349	1, 047
New York	10, 972	17, 858	20, 061	16, 463	25, 690	15, 110	20, 025	18, 116	14, 109	4, 284	6, 860	6, 123
Pennsylvania	14, 240	19, 835	28, 197	34, 702	45, 822	42, 318	51, 870	41, 494	61, 450	35, 294	43, 137	46, 354
Ohio	33, 668	57, 079	73, 543	67, 501	111, 877	113, 892	152, 055	157, 513	149, 845	102, 177	156, 304	166, 845
Indiana	28, 156	52, 964	71, 589	51, 095	115, 482	108, 843	178, 967	195, 496	158, 604	114, 871	187, 635	224, 553
Illinois	22, 634	57, 647	115, 175	129, 921	325, 792	289, 697	398, 149	390, 219	285, 346	275, 850	382, 458	495, 330
Michigan	2, 277	5, 641	12, 445	14, 086	32, 461	28, 786	44, 584	52, 907	45, 089	15, 635	47, 287	38, 715
Wisconsin	379	1, 989	7, 517	15, 034	34, 231	34, 024	53, 310	49, 163	44, 547	26, 019	44, 523	56, 738
Minnesota	------	17	2, 942	4, 743	14, 832	24, 696	47, 257	67, 897	84, 786	104, 419	162, 766	196, 696
Iowa	1, 406	8, 657	42, 411	68, 935	275, 014	313, 131	383, 453	341, 750	371, 362	389, 000	469, 787	632, 340
Missouri	17, 333	36, 215	72, 892	66, 034	202, 414	196, 999	208, 845	191, 427	146, 342	112, 348	124, 058	167, 325
S. Dakota	------	------	20	133	1, 976	13, 152	32, 403	55, 559	69, 061	84, 570	40, 756	109, 399
Nebraska	------	------	1, 482	4, 737	65, 450	215, 896	210, 975	180, 133	160, 391	216, 020	71, 886	223, 580
Kansas	------	------	6, 151	17, 026	105, 729	259, 575	229, 937	154, 652	59, 720	101, 356	31, 880	54, 318
Maryland	8, 233	10, 750	13, 445	11, 702	15, 967	14, 928	19, 767	17, 911	21, 083	14, 543	15, 450	15, 960
Virginia	34, 578	35, 254	38, 320	17, 649	29, 120	27, 172	36, 748	38, 295	42, 303	32, 773	33, 601	34, 645
W. Virginia	------	------	------	8, 198	14, 091	13, 731	16, 611	17, 119	17, 010	11, 656	12, 391	9, 860
N. Carolina	23, 894	27, 941	30, 079	18, 454	28, 020	25, 784	34, 819	34, 064	40, 998	35, 609	50, 797	57, 456
S. Carolina	14, 723	16, 271	15, 066	7, 614	11, 767	13, 770	17, 430	20, 872	27, 472	19, 326	23, 527	26, 885
Georgia	20, 905	30, 080	30, 776	17, 646	23, 202	29, 261	34, 033	39, 375	51, 492	39, 493	37, 604	41, 364
Kentucky	39, 847	58, 673	64, 044	50, 091	72, 852	78, 435	73, 974	83, 348	71, 518	61, 008	61, 052	80, 336
Tennessee	44, 986	52, 276	52, 090	41, 344	62, 764	63, 635	67, 307	67, 682	70, 639	61, 046	54, 905	63, 750
Alabama	20, 947	28, 754	33, 226	16, 978	25, 451	30, 072	35, 053	30, 696	43, 699	35, 684	31, 028	40, 920
Mississippi	13, 161	22, 447	29, 058	15, 637	21, 341	26, 148	38, 790	28, 429	38, 095	34, 936	36, 035	35, 854
Arkansas	4, 847	8, 894	17, 824	13, 382	24, 156	33, 982	44, 144	37, 610	34, 227	27, 388	33, 762	30, 135
Louisiana	5, 953	10, 266	16, 854	7, 597	9, 890	13, 082	22, 063	26, 010	21, 676	18, 280	22, 444	14, 625
Oklahoma	------	------	------	------	------	234	68, 949	94, 283	53, 851	44, 830	25, 341	24, 972
Texas	------	6, 029	16, 501	20, 555	29, 065	69, 112	109, 970	75, 499	108, 377	66, 251	69, 650	53, 686
Mountain States	------	375	800	1, 016	1, 323	2, 333	2, 648	7, 326	16, 758	24, 950	10, 177	12, 772
Pacific States	------	15	592	1, 315	2, 159	2, 776	2, 055	2, 289	5, 197	2, 461	3, 053	1, 965
All other States	7, 400	13, 968	16, 528	14, 009	18, 278	15, 628	22, 325	26, 818	25, 188	17, 238	19, 897	25, 339
U. S. total	377, 532	592, 071	838, 793	760, 945	1, 754, 592	1, 122, 328	2, 666, 324	2, 552, 190	2, 345, 833	2, 130, 752	2, 311, 400	2, 989, 887

[1] Data from Bureau of the Census 1839–1939; estimates for 1946 from Bureau of Agricultural Economics, U. S. Department of Agriculture.

TABLE 3.—*Oats: Production in the United States, by selected States or regions, for specified years, 1849 to 1946* [1]

State or region	1849	1859	1869	1879	1889	1899	1909	1919	1929	1939	1946
	1,000 bu.	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*
New England	8, 101	10, 895	9, 169	8, 840	8, 960	7, 643	7, 350	7, 100	5, 168	4, 574	5, 172
New York	26, 553	35, 175	35, 294	37, 575	38, 897	40, 786	34, 795	21, 595	12, 775	19, 491	32, 360
Pennsylvania	21, 538	27, 387	36, 479	33, 841	36, 197	37, 243	28, 173	29, 183	22, 921	23, 198	30, 033
Ohio	13, 473	15, 409	25, 348	28, 665	40, 137	42, 051	57, 591	46, 818	44, 731	30, 764	62, 235
Indiana	5, 655	5, 318	8, 590	15, 600	31, 492	34, 565	50, 608	52, 530	47, 465	22, 607	56, 160
Illinois	10, 087	15, 220	42, 781	63, 189	137, 625	180, 306	150, 386	129, 105	128, 258	92, 109	168, 693
Michigan	2, 866	4, 037	8, 954	18, 191	36, 961	36, 338	43, 869	36, 956	33, 523	41, 103	71, 890
Wisconsin	3, 415	11, 059	20, 180	32, 905	60, 739	84, 041	71, 349	68, 296	68, 695	64, 515	124, 758
Iowa	1, 524	5, 888	21, 005	50, 611	146, 679	168, 364	128, 198	187, 046	208, 070	155, 348	220, 476
Minnesota	31	2, 176	10, 678	23, 382	49, 959	74, 054	93, 898	89, 108	126, 221	143, 071	192, 168
Missouri	5, 278	3, 681	16, 578	20, 671	39, 820	20, 545	24, 828	40, 494	19, 051	34, 771	60, 884
North Dakota				729	5, 773	22, 125	65, 887	30, 294	31, 175	33, 104	62, 764
South Dakota		3	114	1, 488	7, 470	19, 412	43, 566	51, 092	62, 480	43, 102	100, 398
Nebraska		74	1, 478	6, 556	43, 844	58, 007	53, 360	59, 820	70, 733	18, 225	71, 708
Kansas		88	4, 098	8, 180	44, 629	24, 470	22, 924	36, 257	21, 527	20, 930	40, 556
South Atlantic [2]	26, 673	24, 759	22, 918	25, 703	26, 574	16, 476	22, 583	15, 895	9, 035	15, 965	58, 992
South Central [3]	21, 119	8, 353	12, 865	16, 752	25, 202	13, 705	15, 280	10, 279	2, 576	12, 313	36, 692
Texas	199	986	763	4, 893	12, 581	24, 191	7, 035	63, 989	27, 260	32, 307	36, 366
Oklahoma					76	9, 512	16, 606	45, 470	16, 197	21, 078	24, 780
Mountain	11	72	772	2, 789	5, 951	12, 520	40, 604	14, 458	19, 333	21, 490	31, 156
Pacific	61	2, 063	4, 043	7, 299	9, 685	17, 035	28, 253	19, 398	15, 553	20, 193	21, 626
U. S. total	146, 584	172, 643	282, 107	407, 859	809, 251	943, 389	1, 007, 143	1, 055, 183	992, 747	870, 258	1, 509, 867

[1] Data from Bureau of the Census, 1849—1939; estimates for 1946 from Bureau of Agricultural Economics, U. S. Department of Agriculture.
[2] South Atlantic region includes Delaware, New Jersey, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, and Florida.
[3] South Central region includes Kentucky, Tennessee, Alabama, Mississippi, Arkansas, and Louisiana.

in the production of oats. Usually no plowing is necessary in preparing the seedbed, particularly when the crop follows corn. Oats make their best growth in cool, moist climates. The principal producing States are Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, and Kansas. These States, in 1948, accounted for nearly 85 percent of the total United States production. Most of the varieties grown are white oats. In the Southern and Southeastern States where winters are mild, red oats are grown from both spring and fall sowing.

Barley

Barley was introduced into this country by the early Dutch and English settlers along the Atlantic coast and by the Spaniards on the Pacific coast.[4] In the east the districts first settled were not suitable for barley growing and it was not until central and western New York was settled that a large area favorable to barley production was brought under cultivation. As the settlers moved west-

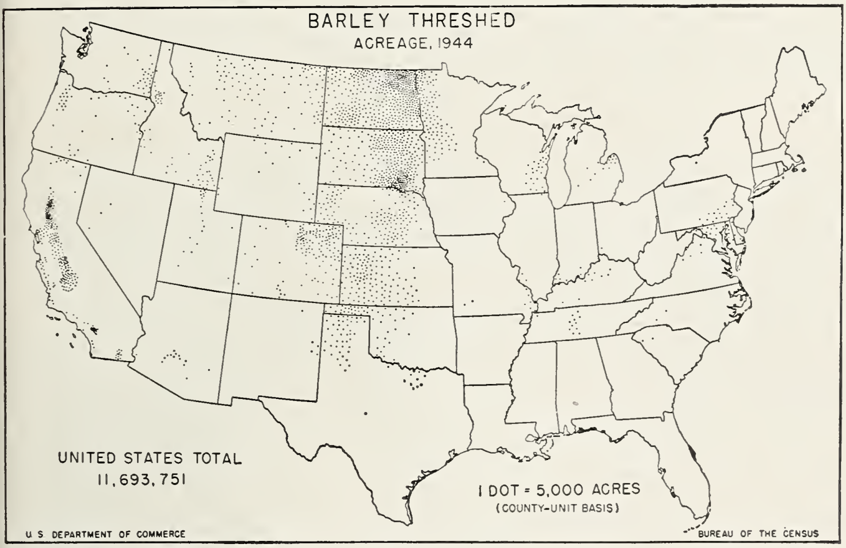

FIGURE 4.—Barley-producing areas in the United States, in 1944.

ward, important barley-producing centers were developed in Wisconsin, Minnesota, North Dakota, South Dakota, and Kansas. In California, where barley grew well, the crop was soon established wherever there were settlers.

The first important eastern barley-producing area was in central New York along the line of the Erie Canal. United States production in 1839 was reported by the Bureau of the Census at a little more than 4 million bushels, 2½ million of which were in New York. Ten years later the barley area was still centered in New York State but production had been started around Cincinnati, Milwaukee, and

[4] See footnote 3, p. 6.

St. Louis to meet the demand for barley for brewing. By 1889 New York was losing its dominant position, as barley production increased in Ohio, Illinois, and Wisconsin, and became important in California. Nearly 16 million bushels were produced that year, of which 4 million were in New York, nearly 4½ million in California, over 1½ million in Ohio, 1 million in Illinois, and smaller quantities in other States.

In the next decade barley culture became common in southern Minnesota and was begun in Washington and Oregon. After the Civil War the barley-growing area extended westward into Nebraska and South Dakota, and the crop totaled nearly 43 million bushels in 1879. During the next 3 decades barley production became concentrated in areas growing the crop largely for malting purposes. The feeding of barley, however, also increased during this period and relatively smaller quantities were marketed. By 1909, production had increased to nearly 175 million bushels. It did not change a great deal during the next 10 years although a 225-million-bushel crop was harvested in 1918. From 1920 to 1940 production in the United States ranged from 133 million to 330 million bushels, the peak being in 1928. During the war years production of barley, stimulated by an urgent demand and relatively high prices, increased along with other grains. The largest crop on record—429 million bushels—was harvested in 1942.

Rye

Rye, an important food grain in some European countries, is a comparatively unimportant crop in the United States. Peak production during the war years 1940–44 was less than 60 million bushels. During the period 1935 to 1939, production averaged less than 45 million bushels annually.

Rye was brought into the New England colonies by English and Dutch settlers. This grain appeared to be of greater importance in New England than in the colonies farther south and very little was produced south of the Potomac River. At the time of the first census in 1839, rye production was centered in eastern Pennsylvania, southeastern New York, northern New Jersey, and central Maryland. The crop that year amounted to about 19 million bushels, of which about one-third was produced in Pennsylvania. Ten years later production had dropped about 4 million bushels. Pennsylvania still held first place, but New York showed an increase in acreage. During the next 10 years the rye area moved westward into the North Central States and production increased about 50 percent. In the decade ended 1869, production dropped slightly but the area had extended into Minnesota, Kansas, and Nebraska.

During the next 30 years, rye production expanded in Michigan, Wisconsin, and Minnesota. Pennsylvania lost its place as the leading rye-producing State. The total 1909 rye crop was reported by the Bureau of Census at nearly 30 million bushels. The greatest shift in rye production since the first census in 1839 occurred between 1910 and 1919. In the latter year North Dakota became the leading State with a crop of more than 16 million bushels. Michigan was next with 12 million, then Minnesota with 8 million bushels. The United States total was nearly 76 million bushels.

Production, stimulated by high prices, continued large during the period of World War I, and reached a peak of approximately 101 million bushels in 1922. During the depression years rye production declined steadily. Export outlets for United States rye were limited and domestic requirements decreased. Prices declined sharply. By 1934, production had dropped to about 16 million bushels. After the outbreak of World War II, production increased to more than 57 million bushels but dropped back to less than 19 million bushels in 1946.

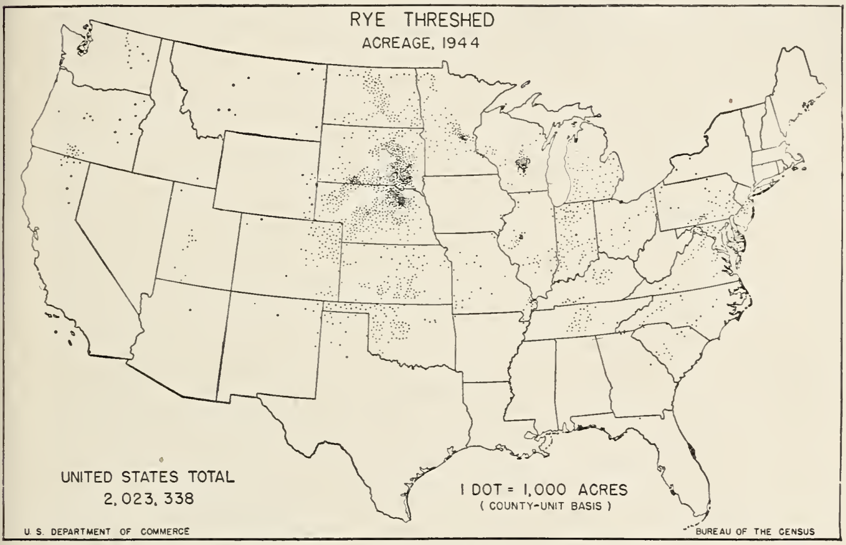

FIGURE 5.—Principal rye-producing areas in the United States in 1944.

Grain Sorghums

Grain sorghums were introduced into the United States in early Colonial times but it was not until well into the eighteenth century that the general types now grown became established. Of these varieties, White and Brown Durra introduced into California in 1874 from Mediterranean Africa were among the first. They were known as "Egyptian corn" and are still grown in limited quantities. About 1879, White Durra appeared in Kansas as "Jerusalem corn." Two varieties of kafir from South Africa came to the United States in 1876 by way of the Centennial Exposition in Philadelphia. A small quantity of this seed reached the State Commissioner of Agriculture in Georgia in 1877 and was sent to Dr. J. W. Watkins of Palmetto, Ga. He grew and selected plants and in 1885 he distributed some seed. The next year he distributed larger quantities through the Georgia State Commissioner of Agriculture.

The sorghum known as Yellow Milo was brought to notice in South Carolina or Georgia about 1885. It was later widely advertised and soon became established in the drier parts of Texas. Production increased rapidly in Kansas and other Southwestern States up to the

period of World War I. Since that time new and better varieties have been introduced.

Grain sorghums being of tropical origin are best adapted to warm, dry sections of the United States. Sorghums are drought-resistant and well adapted to regions of limited rainfall but will also grow where moisture is abundant. Where moisture is adequate, however, corn may outyield grain sorghums and is grown in preference to them. Temperature and moisture conditions along with certain other conditions are most favorable for the crop in Kansas, Oklahoma, and Texas, where production is centered. Considerable acreages also are grown in Nebraska, Missouri, Arizona, Colorado, and California. Information about varieties of grain sorghums and their characteristics may be obtained from Farmers' Bulletin 1764, Growing and Feeding Grain Sorghums.

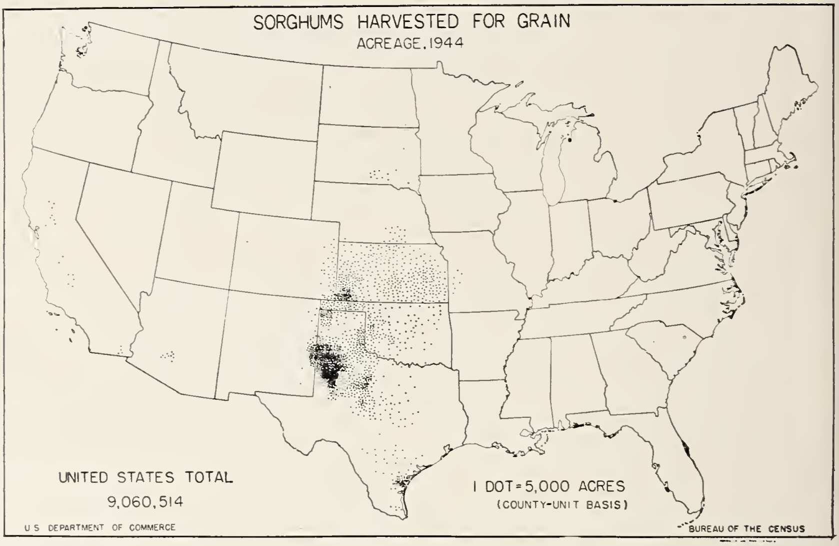

FIGURE 6.—Grain sorghum-producing areas in the United States, principally in the hot, dry sections of Kansas, Oklahoma, and Texas.

Seeding the Grain Crop

Preparing the Land

The first step in producing a grain crop is the preparation of the land. The land must be cleared of trash, plowed, and pulverized to provide a good seedbed that will retain moisture and promote the germination of the seed and the growth of the young plants. In the main grain belt the land is planted to crops every year, but in modern farming, crops are usually rotated so that the same kind of crop is not planted in the same field each year.

By rotating legumes with wheat and corn, the grain yields are maintained. The productivity of the soil is conserved and maintained through the use of farm manures, cover crops, green manures, and chemical fertilizers. In areas where rainfall is light the crops are

usually grown every other year. During the season between crops the land is allowed to rest and is maintained as a clean-cultivated fallow to conserve moisture and nitrates.

Modern implements for preparing the land for seeding are mostly tractor-drawn. In areas where farms are small, horses and mules still provide the power for operating the equipment. For preparing sod land for grain crops in the more humid parts of the Grain Belt, farmers use moldboard or disk plows. Figure 7 shows a moldboard gang plow in operation and figure 8 a disk plow such as is used in the Wheat Belt and the Corn Belt.

The moldboard plow is the more practical where sod or stalks and stubble from previous crops are to be turned under. The disk plows are more generally used in turning either light soil or very hard, dry soil.

After plowing, the soil is conditioned for seeding with disk spike-tooth or spring-tooth harrows. Sometimes heavily weighted drags or corrugated rollers are used to break up the clods.

Where grain seeding follows other grain crops, the soil is often prepared by disking or harrowing only and is not turned over with plows. In the main wheat-producing areas the one-way disk plow is the chief tillage implement. Implements equipped with heavy sweeps or blades also are widely used in preparing the seedbed. All these implements leave the crop residues on or in the surface soil, which protects the land from wind and water erosion. Subsequent tillage in these areas is provided by subsurface implements, such as the rod weeder and duckfoot cultivator, which destroy weeds without pulverizing the surface soil or covering up the clods and crop residues.

Seed Time

Seeding time varies with different crops. The seeding of winter wheat begins about the first of September in the northern sections of the belt and from the first to the middle of October in the southern sections. The seeding of spring wheat begins about the first of March in the southern sections of the main area and April 1 in the northern sections. The seed time for rye is about the same as that for wheat. Winter oats, which are grown mainly in the Southern and Southeastern States, are sown during September and early October. Spring oats, grown principally in the North Central States, are sown mainly during March and April.

There are three important barley-growing areas. The most important is in the North Central States where the crop is seeded as early in the spring as the ground can be prepared. This is usually about the first of April in southern sections and the first of May in northern sections of the area. The Southern and Southeastern States where winter barley is grown comprise the area of next importance. Seeding of winter barley is mostly accomplished in September and October. The third important barley-growing section is in California where the best time for seeding is from late October until mid-January.

The planting of corn which is grown over most of the United States east of the Rocky Mountains begins in southern Texas about the first of February and progresses northward at an average rate of about 13 miles a day. Planting begins about May 1 in the main Corn Belt and

FIGURE 7.—Operating a moldboard plow to turn over sod or heavy soil.

FIGURE 8.—Multiple disk plow for use in large agricultural areas.

Figure 9.—Disk harrow in operation.

Figure 10.—This spring-tooth harrow may be used to pulverize the soil or to destroy weeds when equipped with different teeth.

FIGURE 11.—A spike-tooth harrow putting the ground in condition for seeding.

is completed about a month later. Grain sorghums are a warm-weather crop, and planting is not begun until the soil is warm. In the Southern States the crop can be planted from March until early August, but the best time is from May 15 to July 1.

Selecting Seed

For good crops it is necessary to plant or sow clean seed of good quality. It is also important that desirable varieties adapted to local conditions be selected. Seed of most grains must be treated with some chemical before planting to prevent losses from smut, seed rots, and other diseases. Treatment consists of dusting the seed or in dipping it into a liquid solution to destroy disease-producing organisms which would injure the plant and reduce the crop.

Quantity of Seed Required per Acre

The quantity of seed required to plant an acre of land differs for the various grains and in different sections of the country. The quantity of wheat used for seeding an acre of land ranges from about ⅔ of a bushel per acre in the dry Southwest to a bushel or a little over in the main Hard Winter Wheat Belt. In the main Spring Wheat States, 1 to 1½ bushels are used, whereas as much as 2 bushels are used per acre in the Soft Winter Wheat States of Ohio, Pennsylvania, and New York. For the country as a whole an average of a little less than 1¼ bushels is required to seed an acre.

The average quantity of corn used to plant an acre is only 7.8 pounds. The quantity ranges from 7 to 12 pounds in different States.

About 76 pounds of oats, 77 pounds of barley, 72 pounds of rye, and 8 pounds of grain sorghums are used per acre, on an average, according to statistics compiled by the United States Department of Agriculture and published each year in Agricultural Statistics prepared by the Department. (See page 296 in 1947 issue.)

Seeding Equipment

The seeding of wheat, rye, oats, and barley is now done almost entirely with drills. In the Corn Belt, however, some oats are broadcast by end-gate or other seeders on ground that has been disked. Sometimes the ground is harrowed after seeding. In earlier times grain was broadcast by hand and harrowed into the ground. Drills place

FIGURE 12.—Grain drill with fertilizer attachment.

and cover the seed more uniformly and press it into the moist ground where conditions for germination are more favorable. The drills now used are usually horse-drawn where farms are small but in the important grain-growing areas tractor-drawn drills are the rule. Many drills have fertilizer attachments which sow fertilizer along with the grain to stimulate growth of the plant and increase production. The essential parts of a drill are hoppers to contain the grain and the fertilizer, a mechanism under each hopper to feed out the seed and fertilizer at the desired rate, and tubes to carry the grain and fertilizer down to the disks or shoes which open small furrows to receive them.

Special planters are used to plant corn and grain sorghums in rows that are to be cultivated during the growing season in order to destroy weeds and preserve moisture. Corn planters have about the same essential parts as other seeding machinery. There are hoppers for the seed and fertilizer, perforated plates to select the right quantity of seed, and tubes to carry the grain and fertilizer down to disks or shoes which open a furrow for them.

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There is one important addition to the planter, however, as corn is usually planted in hills so that fields can be cultivated both ways. This is an attachment that when tripped by knots on a wire cable will cause the planter to deposit the desired number of grains of corn and the desired amount of fertilizer in a uniformly spaced hill and not drill the corn in a row like wheat. Sometimes, however, if the crop is to be cut for silage the attachment is not used and the seed is drilled. Modern corn planters will plant two to four rows at a time. In semi-arid regions and in areas subjected to heavy wind and water erosion, corn is often planted with a lister. This is a kind of plow which, in one operation, makes a deep furrow, plants the grain, and covers it with earth.

FIGURE 13.—Operating a four-row planter with fertilizer attachment. Two-row planters are used on small farms.

Cultivating Grain Crops

Small grains, including wheat, oats, and barley, are not cultivated after they begin to grow. On the other hand, row crops, such as corn and grain sorghums, are cultivated two to five times during the growing season. The purpose of the cultivation is to destroy or control weeds which compete with the grain for moisture and nourishment, to maintain a dust mulch in order to retard evaporation, and to prevent rain from running off so that it may enter the soil and supply moisture for the grain.

The crop should be cultivated as frequently as necessary to control weeds. This usually means three or four times a season. The first cultivation is usually with a harrow, rotary hoe, or a weeder, and is done just before the corn comes up or while it is still small. After-

wards, cultivators equipped with shovels, scrapers, or disks, do the work. Guards or fenders on the cultivator protect the plants from being buried by soil while the corn is small. As the plants become taller, the guards are not needed. Modern cultivators plow two to six rows at a time. Some of them are attached directly to tractors. Horse-drawn cultivators are still used on small farms.

FIGURE 14.—Two-row corn cultivator attached directly to tractor.

Harvesting Grain

Time of Harvest

Grain harvesting extends over a period of about 6 months. It begins with winter oats, the cutting of which starts in early May in the Southern States. Next comes the wheat harvest which begins in Oklahoma and Texas about the first of June. Cutting moves slowly northward and ends in the Spring Wheat Belt in August and September. Rye, barley, and spring-sown oats are usually harvested in July and August. In California, small grains are harvested in May and June. The corn harvest follows and starts about the middle of August in the southern belt. Harvesting moves northward during September and ends usually in November. Grain sorghums are harvested from July through November.

Modern Harvesting Machinery

Grain harvesting machinery has been enlarged and improved greatly in recent years. When horses were used for power, harvesters, binders, and threshers were comparatively small in size and capacity. With the

advent of the tractor and its adaptation to farm use, however, the sizes and capacities of harvesting machines were increased. More recently motor power has been built directly into harvesters and combines, and they can now be operated under their own power.

Wheat, rye, oats, and barley are harvested with the same equipment. On small farms and in parts of the East, horse- or tractor-drawn binders are still used.

FIGURE 15.—Tractor-operated grain binder for harvesting wheat, oats, rye, barley, and similar grains.

The grain binder cuts the grain and ties it into bundles. Workmen gather these bundles into shocks in the field where they remain for a short time to cure. When the grain is sufficiently dry, it may be hauled direct from the shocks to the thresher or it may be hauled into the barn or built into stacks or ricks to be threshed later. The thresher or separator threshes out the grain and separates it from the straw and chaff.

In the main Grain Belt where fields are large, most of the grain is now cut with combines. These combines cut and thresh the grain in one operation, thereby saving the farmer considerable time and labor. Grain must be fully ripe and fairly dry to be harvested successfully with a combine. The first combines were drawn by horses, some of the machines requiring as many as 32 horses to operate them. Later the combines were mostly drawn by tractors and the threshing mechanism was operated by gasoline or oil auxiliary engines mounted on the framework of the combine. Many modern combines are self-propelled. These have two power plants, one to propel the combine and one to operate the cutting and threshing mechanism. Large tractor-

FIGURE 16.—Equipment for threshing grain that was cut with a binder.

FIGURE 17.—Harvesting grain with a modern combine operated by one man.

drawn combines require two to three men to operate them. However, smaller combines, which can be drawn by a tractor and operated by one man, are now available.

As grain is combined, it is deposited in a hopper bin on the combine until the bin is full, when it is emptied into a truck. Occasionally it is spouted into a wagon or truck drawn along beside the combine or put into bags which are dropped in the field to be picked up later. The truck hauls the grain to the farmer's bins, to the local elevator, or to a railroad car for shipment.

Corn and grain sorghums, which are row crops, are harvested differently from the small grains. In the North, farmers often cut off the cornstalks with large knives and place them in shocks in the field. Later the ears are shucked from the stalks and placed in cribs for winter feeding on the farm or for sale as cash grain. In the main part of the Corn Belt, the ears of corn formerly were husked by hand from the standing stalks and were hauled to the corncribs. Cattle and hogs were then turned into the cornfields to feed on the leaves remaining on the stalks and on any ears that may have fallen to the ground and been missed by the huskers.

In southern and southeastern producing areas, where corn is grown principally for local farm use, much of the corn is harvested by "snapping." This method consists of jerking or snapping the ear from the stalk with all but the coarsest husk remaining on the ear. The corn is usually placed in storage with the husk still on the ears.

In more recent years corn harvesters have taken the place of hand husking or shucking, in the important producing areas. The corn harvesters are drawn through the field by horses or tractors and the corn is gathered from one or two rows, at a time. Early types of corn harvesters cut the cornstalks and tied them into bundles. These bundles were first shocked in the field and later, after the corn ears became dry enough, the corn was husked by hand in the field or hauled to the barn where it was husked with a power husker. When a power husker was used, the cornstalks and leaves were usually shredded in the husking operation, and were stored in the barn for winter feed.

Modern corn harvesters are called corn pickers. They do not cut off the stalks of corn but pinch off and husk the ears as the machine passes through the cornfield. The most advanced models also shell the corn ready for storage or market.

The essential parts of a corn picker include the gathering arms, equipped with chains, on which are projections which guide the stalks of corn into the machine as it proceeds through the field, straddling the rows. Large corn pickers gather two rows at a time and, therefore, have two sets of gathering arms. As the cornstalks containing the ears are guided into the picker they pass through a set of rolls which pinch off the unshucked ears from the cornstalks. These ears are carried on a conveyor to husking rolls which have roughened and corrugated sections. As these rolls rotate, the roughened sections catch hold of the husks, pull them from the ears of corn, and pass them out of the machine between the rolls. The ears remain above the rolls, which are set on a slight incline, and move to another conveyor which carries them to a wagon or truck drawn alongside the picker. From 10 to 20 acres of corn per day can be harvested with this equipment.

FIGURE 18.—Two-row corn harvester which picks the ears from the cornstalks, husks them, and places them in a truck or wagon for hauling to the corncrib.

Harvesting of corn for silage is important in some areas. Under this method the cornstalks are cut off, either by hand or with a harvester, while they are still green. They are then shredded and placed in a silo. Fermentation takes place in the silo and the shredded material becomes a valuable feed for dairy cows and other livestock.

Grain sorghums, usually planted and cultivated in rows like corn, are generally harvested with a combine. The grain on the sorghum plant grows on the top of the stalk in a large compact head containing many small grains. Grain sorghums are ready for harvest when the seeds are fully colored and have begun to harden.

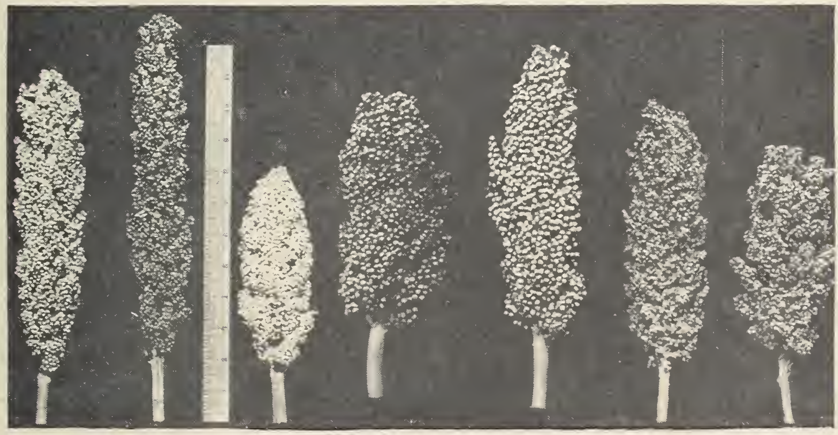

FIGURE 19.—Grain sorghums grow in compact heads on the tops of the stalks.

What Farmers Do With Their Grain

Farmers produce grain for sale in the market, for feed for their livestock, or for their own food. The grain sold in the markets is used for milling or other processing or for shipment to areas where grain is not produced in sufficient quantities for local needs. Some grain is exported to foreign countries. The quantities of the various grains that farmers keep for their own use, or sell, differ materially. A large percentage of the wheat crop, for example, is sold for milling, whereas most of the corn is kept for feeding on the farm.

During the 10-year period 1936–45, an average of 58 percent of the wheat supply was milled into flour and a little over 23 percent was used for feed. During the war period larger quantities of wheat than usual were used for feed because of the scarcity of feed grains. Exports accounted for nearly 6½ percent of the supply and seed requirements accounted for about 8½ percent. Nearly 3 percent was used in the manufacture of alcohol. The use of wheat for this purpose, however, was principally during the war years. About 1 percent of the wheat crop is normally used for the manufacture of breakfast cereals.

Nearly 81 percent of the corn harvested as grain during the 10-year period 1936–45 was used for livestock feed. In addition to this, farmers put about 10 percent of the corn crop into silos or fed it to livestock in the field before it was gathered. Only a little over 3 percent was used for food or in the manufacture of cereals. A little over 4 percent was used for distilling purposes and slightly over 1 percent, on an average, was exported during the period from 1936 to 1945.

Most of the oats which farmers produce is used for feed and seed. Small quantities are exported and about 4 percent of the crop is used in the manufacture of cereal foods. During the 10-year period 1936–45, nearly three-quarters of the barley crop was used for feed and seed and small quantities were exported. The remainder, or about one-fourth of the supply, was used for brewing and distilling purposes and for the manufacture of cereal foods, including pearled barley.

Grain sorghums are mostly used for feed on the farm, or for manufactured mixed feeds. During the war years when other grains were scarce, large quantities of grain sorghums were used for distilling purposes and in starch manufacture. The use of grain sorghums for starch manufacture has expanded further since the war period.

Rye, usually classed as a bread grain, is used not only for milling but also for distilling purposes and for feed. Of the total distribution of rye during the 5-year period 1941–45, the quantity used annually for feed and seed averaged about 63 percent. The quantity milled was about 19 percent of the total distribution, and that used for alcohol amounted to 15 percent. Exports accounted for most of the remainder. Nearly a half of the seeded rye acreage is used for pasture, soil improvement, or hay.

Grain Storage on the Farm

Many farmers store a considerable part of their grain on the farm. Others deliver the grain not needed for farm use to a local country grain elevator or warehouse immediately after harvest. One ad-

vantage of farm storage is that the grain can be marketed at the farmer's convenience or when he believes the price is most advantageous. In storing grain it is important to have the grain in good condition and dry enough for safe storage when it is put into the bins. Clean, dry grain containing not over 14 or 14.5 percent moisture is considered safe for storage in the northern half of the United States. In the South the moisture content of the grain should not be over 13 percent. If grain contains excess moisture when put into storage it is likely to get out of condition—sour, musty, or heat damaged—which adversely affects its feed and market value.

The grain storage bin or granary should be well constructed—sufficiently strong to stand the weight and pressure of the grain—and it should be rodentproof. Where large quantities of grain are to be

FIGURE 20.—A modern farm granary for storing small grains.

stored, the granary should be equipped with machinery to elevate the grain into it, and, it should be constructed in such a way that grain may be removed conveniently and economically.

When crops are larger than usual, farmers sometimes need temporary storage bins until they are ready to sell the grain or until it can be taken in by the local mill or elevator. In such cases metal or wooden bins are frequently used for temporary storage.

Information regarding the construction of farm granaries or elevators may be obtained from Farmers' Bulletin No. 1636, Farm Bulk Storage for Small Grains.

Storage for corn on the farm is somewhat different from that for wheat and other small grains. Since about three-fourths of the corn crop is fed on the farm, relatively large storage facilities are required. Most corn farmers maintain permanent cribs for the storage of corn.

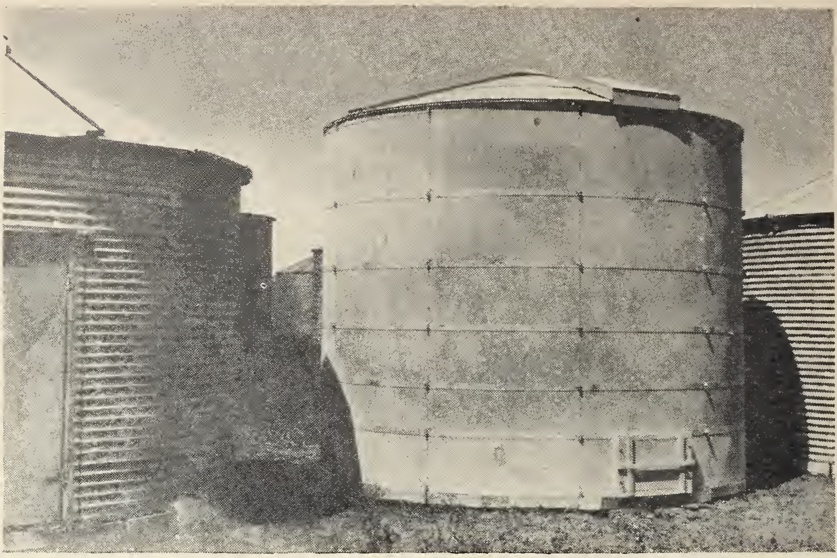

FIGURE 21.—Metal bins for temporary storage of grain on farms or at country shipping points.

FIGURE 22.—A modern corncrib with space for ear corn and with bins above for shelled corn.

In the Corn Belt where large quantities of corn are stored, it is customary to use temporary bins or cribs in addition to permanent corncribs. Some of these temporary cribs consist of wooden platforms surrounded by woven-wire fencing or woven picket or snow fencing. A corncrib of this type holds from 400 to 500 bushels of corn. These cribs should be covered with some type of roofing or with straw or fodder to keep out rain and snow.

The silo is another type of farm storage which is used principally for corn. Silos are generally found in areas where dairying is an important industry. In recent years the corn yield from approximately

FIGURE 23.—Temporary corncribs of woven-wire fencing, covered with boards.

4 million acres has been put into silos in the United States each year. At 1941–45 average yields this would be equivalent to about 135 million bushels of corn annually.

Farm silos are usually constructed of wood, brick, tile, or concrete. They range in size from 10 to 20 feet in diameter and from 20 to 50 feet in height. A silo 16 feet in diameter and 26 feet high will hold about 150 tons of silage.

Pit and trench silos are also used. These silos are made by digging pits or trenches near the feed lot and filling them with the same kind of ensilage as that stored in the above-ground silos. The pit or trench type of silo is practicable where the soil is firm and dry and the groundwater level is low. Temporary silos may be made with fencing or with bales of hay, straw, or fodder. Further information with respect to construction and use of silos may be obtained from Farmers' Bulletin 1820, Silos: Types and Construction.

To retain its greatest feed value, corn harvested for silage is usually cut when about 75 percent of the grain has passed the milk stage and the entire plant contains approximately 70 percent moisture. The corn

may be cut by hand or with a corn binder. When cut by either of these methods it must be gathered immediately, loaded on a wagon or truck, and hauled to the silo where the ensilage cutter chops up the cornstalks, leaves, and ears of corn. Attached to the cutter is a strong fan which forces the chopped ensilage through a pipe up over the top and into the silo.

FIGURE 24.—Farm silo for storing corn silage.

A modern ensilage harvester is being used extensively in areas where large quantities of corn are put into silos. In one operation, this machine cuts and chops the corn in the field and places the ensilage in a truck or wagon drawn along with the harvester. The ensilage is hauled directly from the field and deposited in the silo by use of a fan in the same manner as that employed when an ensilage cutter is used. The harvester method saves handling in the field.

How Farm Storage May Be Financed

The storage of grain on farms often causes a financial problem because growers must pay the production and harvesting costs as they are incurred. Frequently, grain must be sold immediately after harvest to provide funds to meet these expenses.

In 1933, after 2 years of low prices when corn sold at the farm at an average price of about 35 cents per bushel, the Government inaugurated a plan for lending money to farmers on corn when stored on farms in approved cribs or bins. In 1938 the plan was extended to include wheat; in 1939, rye; in 1940, grain sorghums, soybeans, and barley; in 1941, flaxseed; in 1943, hay and pasture seeds; and in 1945, oats.

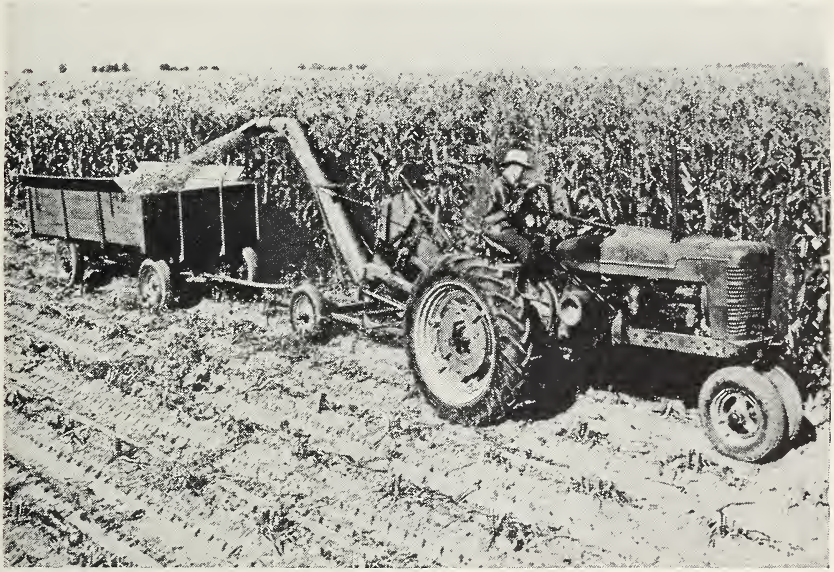

FIGURE 25.—A modern ensilage harvester cutting and shredding the corn to be put into the silo.

Commodity loans are made available through the Commodity Credit Corporation and the loan programs are administered by the Production and Marketing Administration of the Department of Agriculture.

The main features of the loan plan as developed up to 1948 are as follows:

1. The program is administered locally by county agricultural conservation committees under the general supervision of the respective State committees.
2. Loans are made in all States where approved storage is available.
3. Loans are available for designated periods after harvest.
4. A loan may be obtained on storable grain which meets prescribed standards and for which a loan program has been announced.
5. Any person who produces grain as a landowner, landlord, tenant, or share cropper is eligible for a loan.

6. Loans may be obtained through approved lending agencies, including banks, cooperative marketing associations, corporations, individuals, or other legal entities with which the Commodity Credit Corporation has entered into a lending agency agreement.

7. Acceptable storage consists of bins or cribs that are of such substantial construction as to afford protection against loss or deterioration such as caused by rodents, thieves, and weather.

8. The loan rates are established and announced each year as are also the rate of interest, the period when loans are available, duration of the loan, and the time of payment.

Drying Grain on the Farm

In earlier days, small grains such as wheat, rye, and oats were cut, bundled, and shocked in the field for a few days after harvesting to allow the grain to dry out so that it could be threshed in the field, stacked, or placed in the barn to be threshed later. When farmers shifted from the use of the grain binder to that of the combine it became necessary to provide facilities to dry the grain as it came threshed from the combine. In some parts of the country farmers sacked the grain at the combine and stored the sacks, loosely piled, in warehouses. The circulation of air around the sacks removed sufficient moisture to protect the grain from heating and becoming sour and musty. In case of high moisture content in the grain it was necessary at times to turn the sacks and repile them to prevent heating damage.

More recently, farmers have turned to bulk storage for combined grain. This makes it necessary to dry the grain by means of mechanical driers before it can be put into storage. Not many farmers at this time (1949) have driers but they can take their grain to the mill or elevator where it can be conditioned by mixing with dry grain or by running it through grain cleaners which remove some of the moisture. If the elevator or mill has a drier, the grain may be dried and placed immediately in storage.

Some experimental work has recently been done on the construction at the farm of grain bins and corncribs with air ducts installed so that warm, dry air may be blown into these ducts and forced through the surrounding grain to absorb and dry out the moisture in the grain. Experimental drying equipment for use on the farm is shown in figure 26. The essential parts of the drier are a gas or oil burner to heat the air, a fan to force the warm, dry air into the air ducts in the bin or corncrib and through the grain, and a tractor or other power unit to drive the fan.

Cleaning Grain for Market

When grains such as wheat, rye, oats, and barley come from the combine or thresher, they usually contain considerable quantities of weed seeds, trash, or foreign material which must be cleaned out before the grain can be milled or processed. If the grain contains 2 to 3 percent or more of screenings it is usually economical to clean the grain at the farm before it is sold. The cleaned grain will bring a higher price than otherwise, the screenings cleaned out may have feed value

FIGURE 26.—Experimental drier for drying ear corn in a farm crib.

that can be utilized on the farm, and there will be a saving in freight costs if the screenings are not shipped to market with the grain.

Grain sorghums are occasionally stored in the heads as they come from the field at harvest time, and later they are threshed and cleaned for market in the same manner as are oats and barley. If the grain sorghums have been harvested with a combine they are cleaned and stored in the same way as other threshed grain.

Many farmers own grain-cleaning equipment and clean their grain at the farm. The essential features of a grain cleaner are screens to remove the coarse trash, other grains, and foreign material, and a fan to blow out the chaff and shriveled grain. Farmers who do not have their own cleaning equipment frequently take their grain to the local mill or grain elevator for cleaning. Elevator grain-cleaning machinery is usually of greater capacity and likely to be more efficient than the farm grain-cleaning machinery. When farmers depend on the local elevator to clean their grain, they generally do not have it cleaned until they deliver the grain to the elevator for sale or storage.

Corn harvested and stored on the farm is usually in the ear; that is, the grain is still attached to the cob. Some corn is marketed from the farm in the ear, particularly if it is sold to a neighbor or a trucker merchant. In the eastern part of the Corn Belt, corn sold to the local grain merchant is usually in the ear and is shelled and cleaned at the merchant's elevator or warehouse. In other parts of the Corn Belt,

FIGURE 27.—Shelling and cleaning corn at the farm.

the corn is generally shelled and cleaned at the farm just before it is marketed.

The machine or sheller used for shelling and cleaning corn has a revolving cone or plate with small projections for removing the kernels from the cob. The corn is then passed over a screen to remove the cobs and through a strong current of air to remove the chaff.

How Grain Is Marketed at the Farm

There are several outlets for marketing grain at the farm. These outlets include: Neighbors who have not enough grain for their own use and wish to buy additional supplies; local millers and feed manufacturers who depend largely on locally produced grain for their needs; truckers who go through the country and buy grain direct from farmers and sell and deliver it to consumers in areas where supplies are deficient; and local elevator operators who maintain facilities for handling and storing grain and who buy grain at the prevailing market price when it is offered. Farmers also load their grain directly

into railroad cars and ship it to terminal markets or to distant processing plants.

The heaviest marketings of grain usually occur soon after harvest but sizable quantities are marketed each month in the year (table 4). About half of the wheat crop is normally sold during July, August, and September. Approximately half of the rye, oats, and barley crops are marketed or sold before the first of October. The heaviest marketings of corn are in November and December. About one-third of the corn that farmers market each year is sold before the first of January. The largest quantities of grain sorghums are sold in December, January, and February.

Grain Marketing at Country Elevators

Commercial marketing of grain begins at the country elevator or at the local mill or feed manufacturing plant. During the 5-year period 1941–45 over 1½ billion bushels of grain were received annually at country elevators. These elevators numbered about 16,500 in 1948. Country elevators are usually located along railroads in grain-producing areas. Such elevators provide facilities for marketing, conditioning, and storing grain. They vary in size but generally range in capacity from 15 to 50 thousand bushels. The elevators may be constructed of wood, wood with metal cover, steel, or concrete. Modern elevators are usually of concrete construction; at least the storage bins are of concrete.

Grain elevators built before 1900 were generally constructed of wood, and wood is still used in many small elevators. In the wooden type of elevator, the bin walls are 6 to 8 inches thick. These walls are made of planks 2 by 6 inches or 2 by 8 inches—laid flat, one on another, in a style known as cribbing. This type of construction is more satisfactory than is frame construction which requires reinforcement, usually in the form of steel rods running from wall to wall. Wooden elevators are frequently covered with metal for protection from fire and weather. Hollow tile and steel plates are sometimes used in elevator construction but since about 1900 reinforced concrete has been the principal material from which grain elevators have been built. Elevators made of concrete construction are strong and durable and they can be made nearly fireproof. Insurance rates are therefore lower on this type of elevator.

The essential equipment of a country elevator includes: Scales to weigh the grain as it is received from the grower and again when it is loaded into cars or trucks for shipment; bins in which to store the grain until it is ready for shipment; cleaning machines to clean and condition the grain; and elevating machinery for transferring the grain from the receiving bins to the storage bins, to the cleaning machinery, to cars, and trucks. Some country elevators also have driers to remove the excess moisture from the grain in order to make it safe for storage. Most elevators load the grain into cars by gravity; that is, by allowing the grain to drop from the upper part of the building through a loading spout which directs it into the car.

As grain is delivered to the country elevator each truckload or wagonload is weighed to determine the quantity. Truck or wagon scales which weigh loads up to 25 tons are used. These scales are so

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TABLE 4.—*Grain: Monthly sales by farmers, as percentage of total sales years 1945–46 and average for 10-year period, 1934–43*

Grains and year	June	July	August	September	October	November	December	January	February	March	April	May	June
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Wheat:													
1945–46	5. 7	22. 6	18. 6	10. 3	8. 6	4. 8	3. 6	8. 1	3. 2	2. 0	1. 7	9. 5	1. 3
Average 1934–43	6. 0	23. 8	15. 1	10. 5	6. 9	4. 7	5. 3	4. 8	4. 9	5. 3	5. 6	4. 2	2. 9
Oats:													
1945–46	4. 2	10. 2	22. 2	11. 5	7. 3	5. 2	4. 9	8. 8	5. 7	5. 8	5. 2	4. 6	4. 4
Average 1934–43	2. 6	15. 7	21. 0	11. 3	7. 7	5. 2	5. 2	5. 2	5. 4	6. 2	5. 4	5. 4	4. 2
Rye:													
1945–46	1. 9	13. 5	31. 1	15. 5	11. 3	6. 9	3. 6	4. 2	2. 8	3. 1	2. 9	2. 6	. 6
Average 1934–43	. 4	15. 2	23. 3	14. 9	9. 8	5. 9	5. 3	4. 4	4. 0	4. 6	3. 8	4. 1	4. 3
Barley:													
1945–46	7. 1	13. 6	24. 1	14. 6	10. 2	6. 9	4. 1	5. 9	2. 8	3. 2	2. 9	2. 8	1. 8
Average 1934–43	4. 6	12. 4	20. 1	13. 5	9. 3	6. 8	6. 2	5. 6	4. 7	5. 1	4. 5	4. 2	3. 0
	Aug.-Sept.	October	November	December	January	February	March	April	May	June	July	August	September
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Corn:													
1945–46	1. 3	8. 4	12. 0	12. 9	15. 9	11. 8	7. 2	5. 1	5. 2	3. 3	7. 9	4. 9	4. 1
Average 1934–43	. 6	9. 1	11. 5	11 1	9. 6	8. 3	7. 6	7. 2	7. 5	7. 2	6. 3	6. 8	7. 2
	July	August	September	October	November	December	January	February	March	April	May	June	July-August-September
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Grain sorghums:													
1945–46	11. 3	11. 3	7. 9	13. 4	31. 4	8. 5	3. 9	3. 3	2. 4	2. 1	1. 8	1. 8	0. 9
Average 1934–43	-------	3. 7	6. 3	13. 7	18. 4	15. 4	10. 2	7. 7	5. 8	4. 8	4. 3	3. 5	6. 2

FIGURE 28.—A modern country elevator made of concrete.

constructed that a truckload or trailerload of grain can be weighed at one time. Modern scales have an attachment on the weighing beam by which the correct weight may be punched on a card or weight ticket. Some scales also show the weight on a large dial.

After the weighing, the truckload or wagonload of grain is driven onto the platform or dump, under which is a hoppered pit. An opening in the floor of the platform permits the grain to flow from the truck or wagon into the pit. This opening is usually protected by heavy pipe or steel bars which allow the grain to flow through but prevent larger objects or workmen from falling into the pit. The grain is unloaded from the truck by raising the front end of the truck or by lowering the back end.

From the receiving pit or bin the grain is carried to the cleaning machines or to the storage bins by elevating machinery, consisting of metal cups attached to a moving belt enclosed in a metal or wooden

shaft, commonly known as a leg. The grain is picked up by the cups at the receiving bin and carried up the shaft to the elevator head where it is dumped into distributing spouts as the cups pass over the head pulley. If the grain is to be cleaned before it is placed in the bins it is spouted directly to the grain cleaner which is usually located above the storage bins so that the grain may flow by gravity to the bins after it has been cleaned.

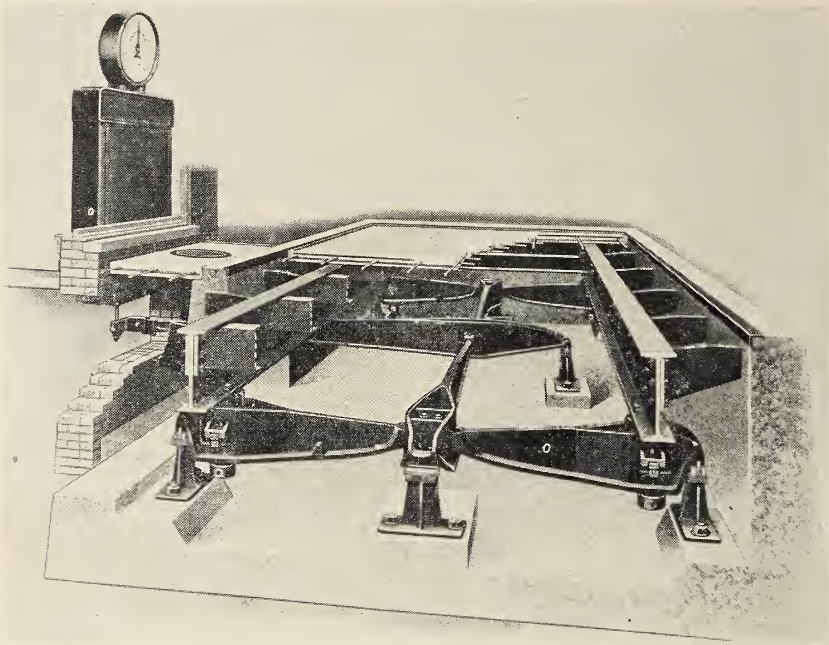


FIGURE 29.—Wagon or truck scales, with a capacity up to 25 tons, for weighing the farmer's grain as it is delivered to the country elevator.

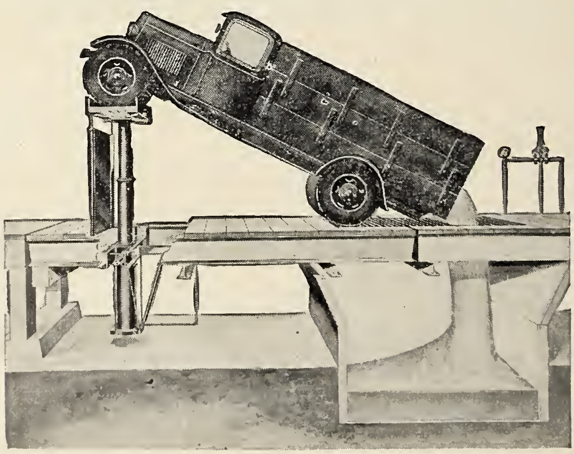


FIGURE 30.—A hydraulic lift for unloading grain from trucks at country elevators.

Cleaning machines in modern country elevators are of two general types: The fanning mill type; and the disk and cylinder pocket machine. The type most commonly used is the fanning mill or general purpose cleaner which utilizes screens or sieves and fans to separate the foreign material from the grain. The screens are usually made of specially woven wire. The sieves are made of perforated zinc or steel. The perforations are of different shapes to adapt them to different grains. The kind of grain to be cleaned and the foreign material to be removed determine the kind and size of screens to be used.

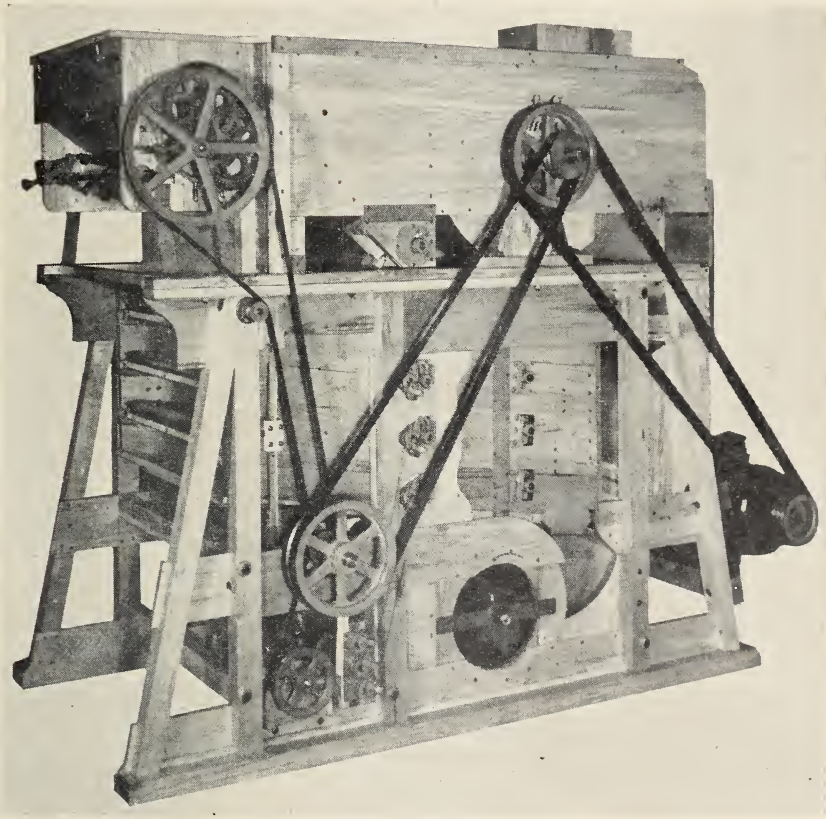


FIGURE 31.—Type of grain cleaner generally used in country elevators.

Trash and coarse materials are separated from the grain by screens located in the upper part of the cleaner. Weed seeds, dirt, and smaller grains are separated by the sieves which are located below the screens. The fans blow or draw out chaff, dust, and other light material. The capacity of this type of grain cleaner ranges from 100 to over 3,000 bushels per hour, depending on the screen surface and the strength of the air current produced by the fan.

Pocket machines are more effective in separating different kinds of grain mixtures and in removing weed seeds than are the screen or sieve types. The principal pocket machines use indented vertical disks and

cylinders. All pocket machines make separations on the principle of grain lengths. In cleaning wheat, for example, weed seeds shorter than the wheat kernels fall into and remain in the pockets as the disk or cylinders rotate and are carried out of the grain and discharged into a trough or hopper. In separating wheat and oats, the wheat remains in the pocket and the oats, which are longer, are discarded. The indentations or pockets are of different sizes to adapt them to the different kinds of grain to be cleaned.

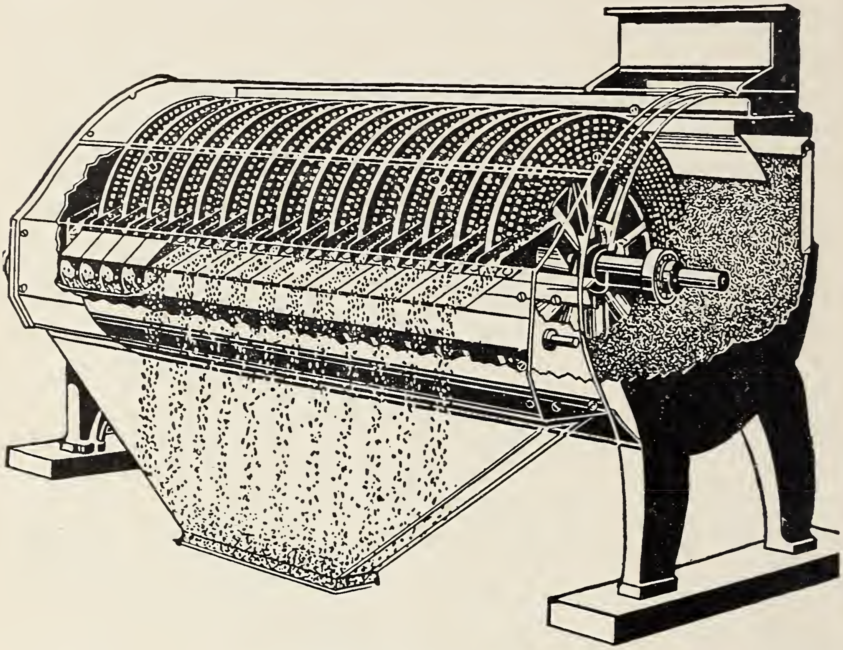


FIGURE 32.—Pocket, or disk, cleaner for separating mixed grain and removing weed seeds.

There are several special types of grain cleaners and separators but most of them use the principles already described. These cleaners are used by millers, seedsmen, maltsters, and others. They are not usually included in the equipment of country elevators.

In some parts of the Corn Belt, country elevators receive the corn in the ear and have shellers and cleaning machinery to prepare it for market.

Corn shelling and cleaning equipment used in country elevators differs somewhat from that used on farms. Usually, such equipment in a country elevator is of greater capacity than that used on farms and it is permanently installed in the elevator as a part of the grain-handling machinery. An elevator or warehouse sheller can shell from 250 to 2,000 bushels of ear corn per hour, depending on its size. Such corn shellers require from 10 to 30 horsepower to operate them.

The corn sheller is usually installed in the basement of the elevator so that the ear corn can be fed into it by a chain belt from the pit or hopper into which the ears have been dumped from the wagon or truck.

As the ears of corn pass through the sheller the grain is removed from the cobs, which usually become considerably broken by the operation. The entire mass of cobs and corn is elevated directly from the corn sheller to the cleaner, where cobs, husks, and other extraneous material are removed.

Corn cleaners are of the screen and fan type and may be the same as those used for wheat and other small grains. In one type of corn cleaner in common use, however, the screens revolve instead of shake and they do not clog readily. All coarse material is removed by the screens. The husks, small broken pieces of cobs, and other like substances are drawn or blown out by the air current from the fan.

In modern elevators the storage bins have hoppered or sloping bottoms with openings at the lowest points from which the grain may be drawn. The flow of grain through such an opening is controlled by a sliding gate which usually is operated from the working floor of the elevator. When the grain is drawn from the bins through these gates it falls on a moving belt or into a conveyor which carries it to loading elevators. In some houses the grain flows by gravity through spouts from the bins to the elevating machinery.

When the elevator owner or operator wishes to ship out grain, it is drawn from the storage bins and elevated to cleaning or weighing machinery, usually located at or near the top of the elevator. If the grain is to be recleaned before loading it is run through the cleaner and then to the scale. If it has already been properly cleaned it is run directly into the scale which may be hopper-type or automatic. In the hopper-type scale the grain is run into the hopper and weighed with weights on a scale beam. After weighing, the grain is drawn out into the loading spout and another lot is run into the hopper for weighing. The automatic type of scale operates continuously. It weighs smaller quantities at a time than does the hopper scale. It is usually set to weigh 5 to 10 bushels. When the quantity which the scale has been set to weigh has been received the flow of grain is momentarily cut off while the weighed lot is dumped into the loading or distributing spouts. As soon as this is accomplished the scale automatically receives and weighs the next lot and continues these operations until the weighing is completed.

Most country elevator owners and operators will either buy outright the grain that is offered by the farmers or they will accept the grain for storage. Some operators with small privately owned elevators will not accept grain for storage because their limited bin space is needed for their own operations.

Country Warehouse Storage of Grain

If the grain is sold to the elevator operator or grain merchant, the farmer is paid promptly by cash or check after he has completed delivery. If the grain is placed in the elevator for storage, the elevator owner issues to the farmer or producer a storage ticket or warehouse receipt which states the quantity, kind, and grade of grain. The receipt states also the terms under which the grain is stored and the responsibility of the warehouseman with respect to keeping the grain in good condition and in delivering it again to the grower. Most States have laws which cover the storage of grain in public or private

elevators, but these differ materially in their requirements. They are all designed, however, to protect the farmer who places his grain in storage.

In some States regulations permit the warehouseman to ship grain, which he has accepted for storage, to terminal market elevators for

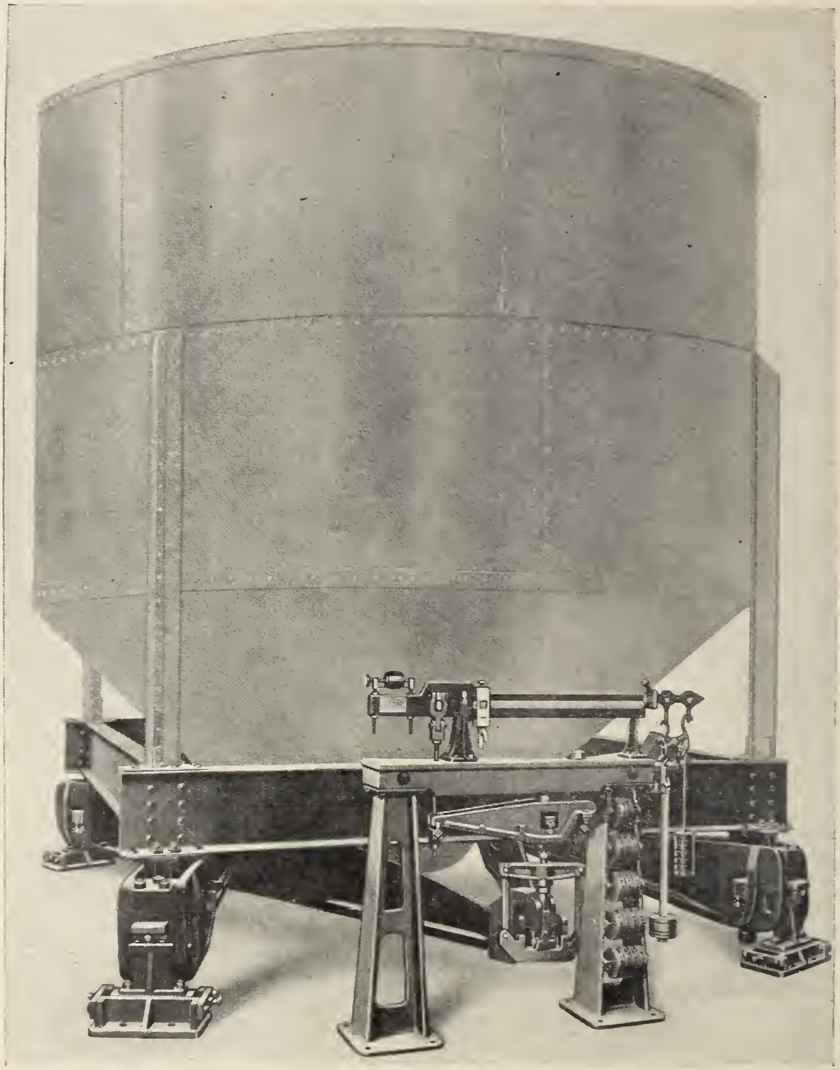


FIGURE 33.—Hopper scale for weighing the grain before it is loaded into cars.

storage when his own elevator is filled and space is needed for storing other growers' grain. In such cases the warehouseman is not required to return to the grower the identical grain which he placed in storage but may fulfill his obligation to the grower by furnishing him a terminal market warehouse receipt for the same quantity of a like class

and grade of grain. Since warehouse receipts are usually negotiable (that is, they may be bought and sold), the grower can sell his warehouse receipt as if it were the actual grain.

The storage plan which best safeguards the grower is that approved under the United States Warehouse Act. An elevator owner or warehouseman who operates under this act is licensed by and is required to furnish a bond acceptable to the Secretary of Agriculture. Only warehouses open to the public for the storage of commodities are licensed. The warehouseman must have a good business reputation and acceptable assets. The elevator or warehouse must be suitable for the storage of the commodity. Representatives of the United States Department of Agriculture make frequent inspections after a warehouse is licensed to see that the regulations of the United States Warehouse Act are faithfully observed and carried out.

The warehouse receipts issued by licensed and bonded warehousemen, who are operating in accordance with the United States Warehouse Act, are negotiable and are readily accepted by banks as collateral for loans. These receipts also assure the grower that his grain is in safe storage and can be obtained upon surrender of his warehouse receipt.

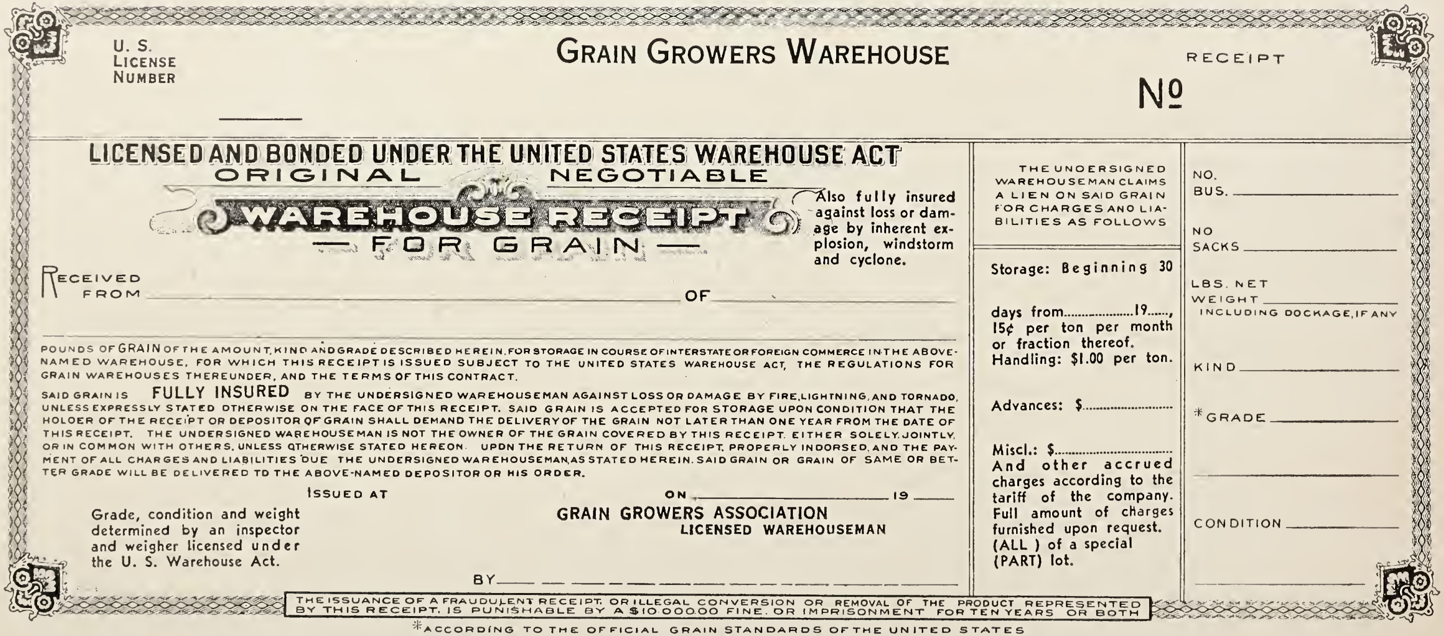
The cost of storing grain in country elevators varies considerably in different areas. The cost of receiving the grain, placing it in the elevator, and of delivering the grain to the owner at the close of the storage period usually ranges from 3 to 5 cents per bushel. From 1 to 1½ cents per bushel per month is the usual charge for storage, with an additional charge of ½ cent per bushel for insurance and for handling the grain to keep it in good condition. On this basis, a year's storage would cost about 15 to 25 cents per bushel. However, much of the grain placed in storage is stored only for a few months; also, some elevator owners allow some free time and they may reduce certain charges if the grain is sold to them.

In the western part of the United States, some growers still bag their grain as it comes from the combine or thresher. This grain is usually stored in flat warehouses in bags and frequently remains in the bags until it reaches the mill or the terminal market elevator, or is dumped into the hold of a ship for export or for shipment to other seaboard markets in the United States. Storage costs in flat warehouses do not differ materially from those in bulk grain elevators except that there is a charge for piling and handling the bags in lieu of the unloading and elevating charge at bulk handling plants.

Grain-Drying Facilities at Country Elevators

Some of the more modern country elevator operators have grain driers which enable them to handle grain direct from combines and to condition other grain of high moisture content. Commercial grain driers operate on the principle of absorbing the moisture from the grain by forcing currents of warm, dry air through it.

A grain-drying plant usually includes: A dump or bin to receive the grain from the wagon, truck, or car; elevators to carry the grain to the cleaning machinery, drying units, and storage bins; fans to force warm air through the drying unit; and a furnace to heat the air.


U. S. LICENSE NUMBER

GRAIN GROWERS WAREHOUSE

RECEIPT №

LICENSED AND BONDED UNDER THE UNITED STATES WAREHOUSE ACT

ORIGINAL NEGOTIABLE

WAREHOUSE RECEIPT

— FOR GRAIN —

Also fully insured against loss or damage by inherent explosion, windstorm and cyclone.

RECEIVED FROM ______ OF ______

POUNDS OF GRAIN OF THE AMOUNT, KIND AND GRADE DESCRIBED HEREIN, FOR STORAGE IN COURSE OF INTERSTATE OR FOREIGN COMMERCE IN THE ABOVE-NAMED WAREHOUSE, FOR WHICH THIS RECEIPT IS ISSUED SUBJECT TO THE UNITED STATES WAREHOUSE ACT, THE REGULATIONS FOR GRAIN WAREHOUSES THEREUNDER, AND THE TERMS OF THIS CONTRACT.

SAID GRAIN IS FULLY INSURED BY THE UNDERSIGNED WAREHOUSEMAN AGAINST LOSS OR DAMAGE BY FIRE, LIGHTNING, AND TORNADO, UNLESS EXPRESSLY STATED OTHERWISE ON THE FACE OF THIS RECEIPT. SAID GRAIN IS ACCEPTED FOR STORAGE UPON CONDITION THAT THE HOLDER OF THE RECEIPT OR DEPOSITOR OF GRAIN SHALL DEMAND THE DELIVERY OF THE GRAIN NOT LATER THAN ONE YEAR FROM THE DATE OF THIS RECEIPT. THE UNDERSIGNED WAREHOUSEMAN IS NOT THE OWNER OF THE GRAIN COVERED BY THIS RECEIPT EITHER SOLELY, JOINTLY, OR IN COMMON WITH OTHERS, UNLESS OTHERWISE STATED HEREON. UPON THE RETURN OF THIS RECEIPT, PROPERLY INDORSED, AND THE PAYMENT OF ALL CHARGES AND LIABILITIES DUE THE UNDERSIGNED WAREHOUSEMAN AS STATED HEREIN, SAID GRAIN OR GRAIN OF SAME OR BETTER GRADE WILL BE DELIVERED TO THE ABOVE-NAMED DEPOSITOR OR HIS ORDER.

ISSUED AT ______ ON ______ 19 ___

Grade, condition and weight determined by an inspector and weigher licensed under the U. S. Warehouse Act.

GRAIN GROWERS ASSOCIATION
LICENSED WAREHOUSEMAN

BY ______

THE UNDERSIGNED WAREHOUSEMAN CLAIMS A LIEN ON SAID GRAIN FOR CHARGES AND LIABILITIES AS FOLLOWS

Storage: Beginning 30 days from .... 19...., 15¢ per ton per month or fraction thereof.
Handling: $1.00 per ton.

Advances: $..........

Miscl.: $..........
And other accrued charges according to the tariff of the company. Full amount of charges furnished upon request.
(ALL) of a special (PART) lot.

NO. BUS. ______

NO SACKS ______

LBS. NET WEIGHT ______
INCLUDING DOCKAGE, IF ANY

KIND ______

*GRADE ______

CONDITION ______

THE ISSUANCE OF A FRAUDULENT RECEIPT, OR ILLEGAL CONVERSION OR REMOVAL OF THE PRODUCT REPRESENTED BY THIS RECEIPT, IS PUNISHABLE BY A $10,000.00 FINE, OR IMPRISONMENT FOR TEN YEARS OR BOTH

*ACCORDING TO THE OFFICIAL GRAIN STANDARDS OF THE UNITED STATES

FIGURE 34.—The kind of warehouse receipt that is issued by warehousemen who are licensed and bonded under the United States Warehouse Act.

The receiving bin or dump is usually located under the driveway or at some equally convenient place so that the grain may be unloaded directly into it from the farmer's wagon or truck. The grain is carried from the receiving bin or hopper by conveyor or elevator to cleaning machinery or receiving bins located above the drying unit. These are generally so arranged that the grain may pass directly from them to the drier.

The most important part of the drying plant is the drying unit. This consists of upright rectangular, hollow structures through which

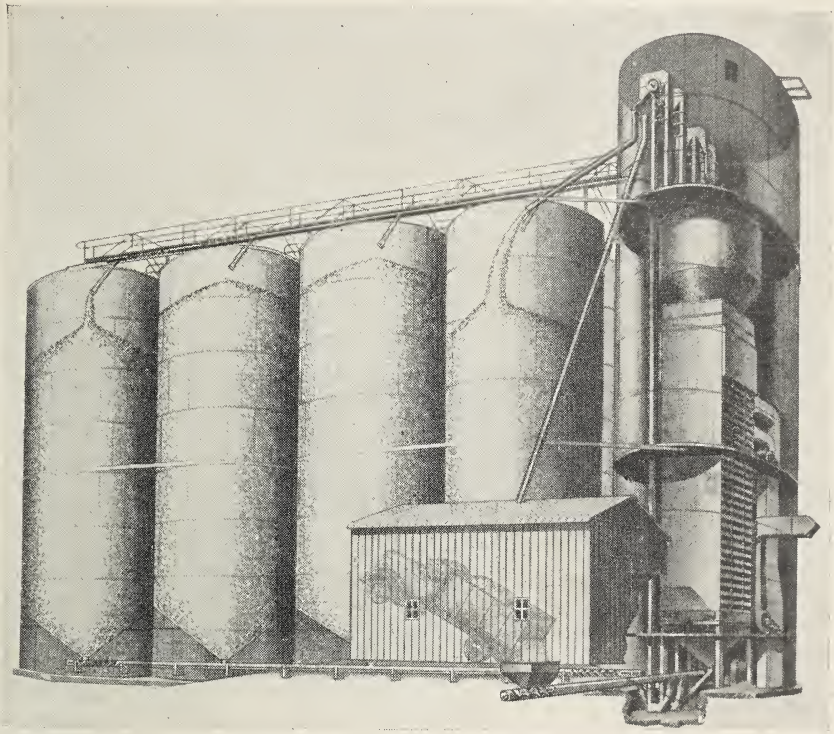


FIGURE 35.—Model of a drier used to remove excess moisture from grain before the grain is placed in storage.

the grain to be dried flows from the small bins or hoppers at the top in a thin stream or column to a conveyor at the bottom. The columns usually contain baffle boards or some other device to break up the column of grain so that the air may pass through it more readily. The sides of the drying units are usually covered with perforated metal or heavy screens to permit the warm, dry air to pass through the column of grain. The air enters the column of grain from the bottom of the unit and is driven upward by fans and out through the vents. The rate at which the grain flows through the drier is adjusted so that the grain reaches the desired degree of dryness as it passes through the unit. In one type of drier the grain remains stationary and after it has been properly dried through the application of dry air it is drawn out and replaced by another lot of damp grain.

The air used in the drier is usually heated by oil or gas burners and is forced into the unit by fans. The air is kept at a temperature that will not injure the grain but will absorb the greatest amount of moisture. Most grain driers have storage or cooling bins in which the dried grain may be stored until it is ready to be delivered back to the grain grower, loaded into a car, or transferred to the grain elevator for permanent storage.

Ownership of Country Grain Elevators or Warehouses

Country grain elevators fall into three general groups: (1) Private: (2) line elevators; and (3) cooperative elevators. The private elevator is usually owned by a local individual or firm and is most common in diversified farming areas. In such areas several different kinds of grain are commonly grown for market. The quantities of each may not be large but some kind of grain is usually sold throughout the year. This requires that the elevator be open for business the year-round. In some instances the owner handles a side line, such as feed, coal, cement, lumber, farm machinery, and other items needed by the farmers in his territory.

Line elevators are mostly located in important winter and spring wheat-producing areas. They are called line elevators because they are owned and operated usually by a large milling concern or terminal market grain firm, in large groups or lines generally located along a railroad system. These elevators are in charge of a local manager but the business is usually directed from the headquarters of the firm which owns or leases them. Some line elevator companies also handle farm supplies as a side line.

Cooperative elevators, as the name implies, are cooperatively owned by grain growers, and the net earnings from the elevator are prorated back to the growers on a patronage or share basis. Cooperative ownership may be limited to only one elevator or it may extend to a full line of country elevators. In some instances cooperative organizations also own milling and terminal marketing facilities. Aside from different methods of financing and of distributing the earnings of the business there is practically no difference in the manner in which grain is handled in the different types of country elevators.

How and Where Country Elevator Operators Market Grain

Country elevator owners and operators have numerous outlets for their grain. Some is sold locally to stockmen, dairymen, poultrymen, or to farmers who need more grain than they have produced. Considerable quantities are sold and shipped direct to millers, feed manufacturers, and feeders in deficit producing areas. The bulk of the grain handled in country elevators, however, goes to terminal markets by rail. Large quantities can be moved readily by railroad as modern (1949) freight cars have a carrying capacity of 80,000 to 100,000 pounds and may be loaded to 10 percent over the marked capacity. The larger cars hold up to 1,830 bushels of wheat or 1,960 bushels of corn or rye.

In some areas considerable quantities of grain are shipped from country elevators in motortrucks. These shipments usually go to

nearby destinations, although commercial trucking companies now haul grain for distances of a hundred or more miles. Trucking costs are generally lower than railroad freight rates for short hauls, and motortrucks have the further advantage of being able to deliver direct to the purchaser. This is of particular advantage to the consignee who does not have a private railroad siding on which cars can be placed for unloading into his mill, warehouse, or processing plant.

When the country elevator operator has grain ready for shipment he notifies the local agent of the railroad over which he plans to make shipment that he requires one or more cars for shipping grain. He usually specifies the type and size of car needed and indicates the destination to which the grain will be shipped. The agent forwards this request to the division car distributor of the railroad and he in turn locates an empty car and dispatches it to the elevator shipping point where it is placed by the local freight crew on the railroad siding beside the grain elevator.

After placement, the car is made ready for loading by the elevator employees. This includes making minor repairs, cleaning out any trash or other material left in the car by the previous shipper and sweeping it clean of all dust and dirt. It is also necessary to install grain doors furnished by the railroad. These are in the form of fabricated doors which fit inside the frame of the regular door and are nailed in place. When the cars are unloaded at terminal markets, mills, or processing plants these doors are removed and returned to the country elevators for use in other cars.

At most elevators grain is transferred from the elevator into the car by gravity through a spout from an automatic or hopper scale located near the top of the elevator. At some elevators, power loaders, which drive the grain into the car by a strong blast of air, are used. When the desired quantity of grain has been loaded into the car the outside doors are closed and sealed with a metal seal placed on the lock by the shipper or the local railroad agent.

Before the railroad company will move the car it must have information as to where and to whom the car is to go. This information is furnished by the shipper on a bill of lading. There are two types of bills of lading: The straight bill of lading, and the order bill of lading. The straight bill of lading is not negotiable. It is an agreement between the shipper and the carrier by which the latter agrees to accept, transport, and deliver the goods of the shipper to the consignee at a stated destination. The straight bill of lading is usually used for shipments when the shipper has full confidence in the integrity and responsibility of the consignee.

The order bill of lading is also an agreement between the shipper and the carrier but it is negotiable; that is, the ownership of the commodity which the bill of lading covers may be transferred by an endorsement. Grain shipped on an order bill of lading will not be delivered to the consignee until the original document is surrendered or a surety bond is posted by the receiver. This provision of an order bill of lading assures the payment of any draft that may be attached to it and also, if properly used, protects the shipper against irresponsible or dishonest buyers.

If a grain shipper needs or desires to obtain an advance of funds on his shipment he may prepare a sight or an arrival draft for up to about

80 percent of the market value of the grain and may forward it, attached to the bill of lading, to the buyer through his local banker. The banker will usually credit the shipper's account immediately with the amount of the draft if it is attached to an order bill of lading, since this assures payment of the draft before the consignee can obtain possession of the grain. A sight draft requires payment when presented to the consignee by the bank to which it has been forwarded by the shipper's bank. An arrival draft need not be paid until the shipment has arrived. In order that the buyer may examine the grain he has purchased, before paying either the sight or arrival draft, the shipper usually makes a notation on the bill of lading to the effect that inspection is allowed.

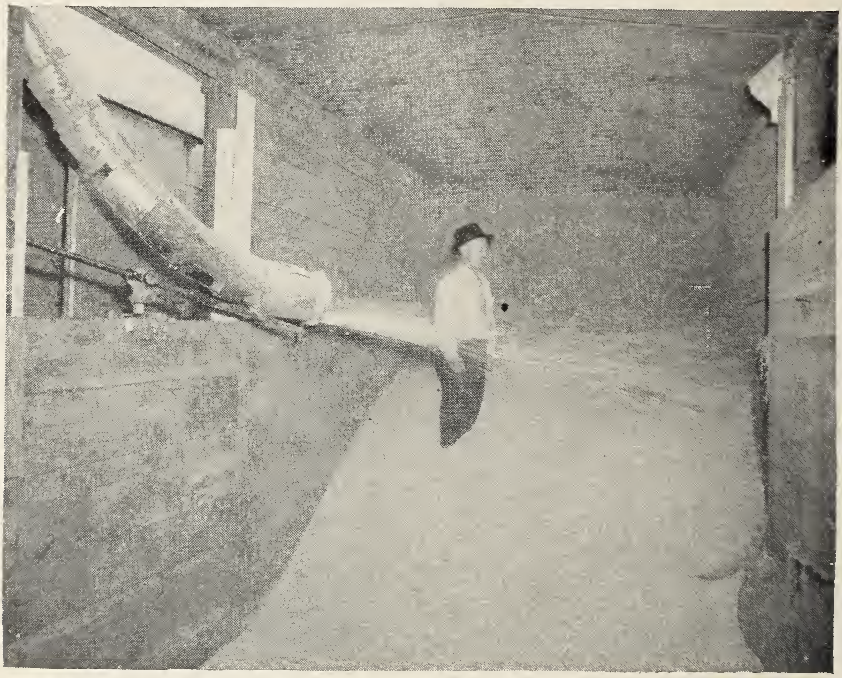


FIGURE 36.—Loading grain into a car by gravity through a curved spout.

Marketing Grain at Terminal Markets

Despite the increased movement of grain direct from producing to consuming areas in recent years the bulk of the grain that leaves the farm each season still reaches the terminal market for processing or distribution. Receipts of grain at the principal terminal markets during the 1946–47 marketing season totaled more than $1\frac{1}{4}$ billion bushels.

Terminal markets provide many services and facilities for marketing grain. Among these are weighing and inspection services; drying and storage facilities; trading floor privileges; market quotations; services of salesmen and commission merchants; and services of financing, insurance, and forwarding agencies.

Grain trading at terminal markets is under the supervision and control of local organizations commonly called grain exchanges, boards of trade, or chambers of commerce. The membership of these organizations includes principally grain merchants, commission men, millers, oilseed crushers, feed manufacturers, other grain processors, and representatives of transportation and storage companies. The management of the exchange or board of trade is usually vested in a board of directors. These directors are elected by the members of the organization and are chosen in such a manner that they represent a cross section of the industries that have members in the exchange. Most exchanges are authorized by law to set up a board of arbitration and appeals to hear testimony in controversies among the members and to make decisions and awards.

Grain exchanges provide facilities for trading both in cash grain and in futures contracts. Cash grain trading is regulated by the rules of the exchange but individuals and firms engaged in the grain trade are subject also to State and Federal laws. Futures trading is covered by a Federal law—the Commodity Exchange Act—administered by the United States Department of Agriculture.

Farmers, country elevator operators, or others who wish to ship grain to a terminal market may either consign the grain to the market for immediate sale or they may sell their grain before shipment, commonly termed "to arrive," to some merchant or processor at the terminal market. When a shipper wishes to consign his grain he first selects a commission merchant at the terminal market who will receive and sell the grain for him. The commission charges range from 1 cent to as much as 3½ cents per bushel, depending on the type of grain in the shipment. Other charges paid by the shipper, in addition to the freight costs, include an inspection fee ranging from about $1 to $2.50 per car, a protein test (if wheat) at $1, and weighing charges of $1 to $2 per car. These charges vary at different markets and are determined in part by the volume of business at the market. It is also customary for the commission merchant to charge interest on any money he may have advanced on a draft. The total cost to the shipper of marketing a car of grain on a commission basis would range from about $20 to $50 per car, not including transportation costs.

If the country grain shipper does not care to take the risk of price changes that might occur while his grain is in transit to the market on consignment, he can usually find a cash grain firm at the terminal market that will buy his grain at a definite price for shipment within a specified time. This means that the buyer assumes the risk of market changes while the grain is moving to the terminal market. The advantage of this plan to the shipper is that he knows what he will receive for his grain at the shipping point, provided that he delivers the quality of grain he contracted to sell. The price a terminal market dealer will pay for grain "to arrive," is usually somewhat lower than the equivalent "cash sales" price at the terminal market on the day of purchase because of the marketing risks which he assumes. On consigned grain the shipper bears the marketing risks. However, both shipper and buyer may insure themselves against losses resulting from price changes through the use of futures markets. Futures trading is discussed in another section of this publication.

How Grain Is Handled at Terminal Markets

On their arrival at terminal markets, cars of grain are placed immediately by the railroad company on tracks in their holding yards. Yard clerks immediately notify the grain inspection department from which trained men are sent to obtain samples of the grain. Samples are drawn by probing into the grain, at five or more different places, with a double-tube compartment trier, 5 feet long. As each probe of grain is drawn, the grain is emptied onto a canvas for examination regarding mixture, odor, and evenness of loading.

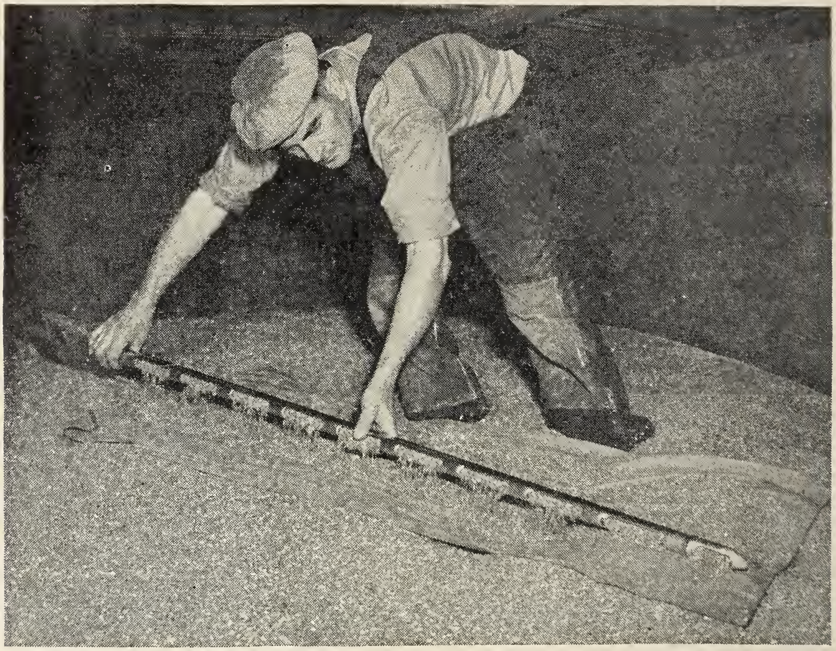


FIGURE 37.—Drawing a sample from a car of grain. This is the first step in grain inspection at terminal markets.

After the preliminary examination, the sample of grain is placed in a moisture-proof bag and is taken to the inspection laboratory of the grain inspection department for determination of class and the grade of the grain. Tests are made to determine the test weight per bushel, which is a grading factor in all grains. Tests are also made for moisture content.

Much of the grain that arrives at the terminal markets contains weed seeds, chaff, or other foreign material. This is called dockage and must be removed in the process of determining the grade. The removal of the dockage is accomplished with appropriate sieves and grain-cleaning devices or by hand-picking. The grain sample is also analyzed for damage, mixture of other grains, and foreign material. Other tests are made, such as protein determinations for wheat intended for milling and oil content for flaxseed and soybeans. These

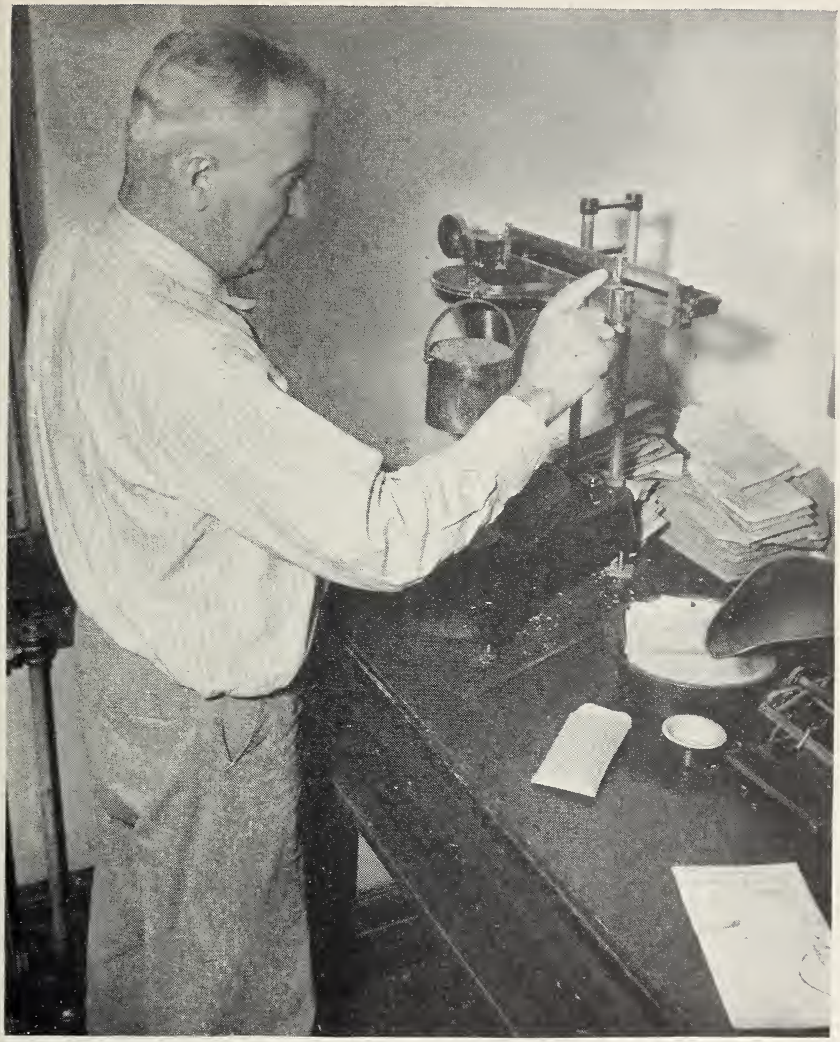


FIGURE 38.—Determining the test weight per bushel of a representative sample from a carload of wheat. The bucket in which the wheat is weighed holds 1 quart and the scale beam is calibrated so as to register the number of pounds that a full bushel of such wheat will weigh.

tests, however, are usually made in separate and specially equipped laboratories.

The inspection department which provides the sampling and inspection or grading service at the terminal market is operated by the State in which the terminal market is located, or by a grain exchange or board of trade. In all cases the inspectors are licensed and the work is supervised by the United States Department of Agriculture under the authority of the United States Grain Standards Act. Offi-

ces for the administration of the United States Grain Standards Act, including the handling of appeals, are maintained at all the important terminal markets and at a number of secondary grain markets.

Official Grain Standards

In the early days of grain marketing each local trade organization adopted its own set of standards and its own methods of applying them. In some markets different interests favored different kinds of grain standards. Millers generally favored high standards, well

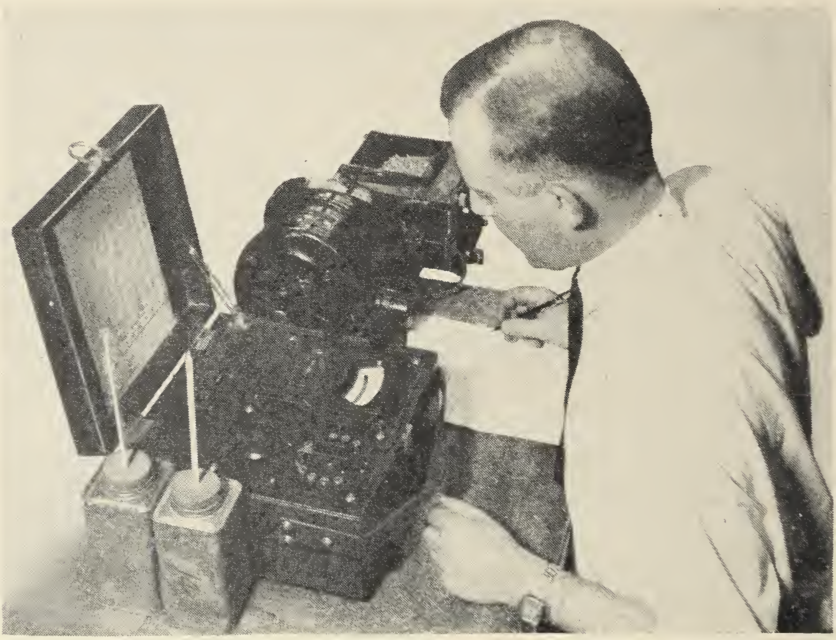


FIGURE 39.—Modern electric equipment used to determine the moisture content of grain.

maintained; others who were interested in making profits on the quantity of grain handled frequently favored liberal standards, leniently applied. For many years grain organizations tried unsuccessfully to establish a single or uniform set of standards that could be consistently interpreted and applied. Complaints were made to the United States Government by foreign buyers of United States grain as well as by some American firms, about the unsatisfactory inspection and grading situation. At that time the Federal Government had no jurisdiction over State and commercial inspection and grading departments.

In 1901 the United States Department of Agriculture began to study the various commercial standards and methods of applying them. As a result of those studies permissive Federal standards were established for shelled corn in 1913. These standards were soon adopted by many grain inspection departments but there continued to be a serious lack

of uniformity in their application. In 1916 Congress passed the United States Grain Standards Act. This act, under which State and commercial grain inspection departments are now operating, provides in part for: (1) The establishment of grain standards; (2) the Federal licensing of grain inspectors and supervision of their work; and (3) the entertaining of appeals from the grades assigned by the licensed inspectors.

Official standards have now (1949) been established for wheat, shelled corn, barley, oats, rye, grain sorghums, flaxseed, soybeans, feed oats, mixed feed oats, and mixed grains.

Selling Cash Grain

When cars of grain arrive at a terminal market notice of their arrival is sent by railroad agents to the person or firm to whom the shipment has been consigned or billed as well as to the inspection department which samples and grades the grain. The commission merchant or buyer, therefore, is prepared to handle the grain as soon as the graded samples are received from the inspection department.

At most of the larger terminal markets, the local grain exchange or board of trade provides space on the trading floor for tables on which the samples of grain, offered for sale, may be displayed during the trading period, which is from about 9 a. m. to 1:30 p. m. The samples are displayed in pans or other containers holding about a quart of grain. With each sample is a ticket which identifies the grain by showing the initials and number of the car in which the grain arrived. The ticket also shows the class and grade of the grain, together with information on such grading factors as moisture content, test weight, and/or dockage. For wheat intended for milling there is also a ticket showing the protein percentage as determined by a protein-testing laboratory.

During the trading period members of the exchange who are interested in buying grain move about among the tables, examine the grain samples, and make offers on such lots as they may wish to buy. If the offer is accepted the trade is completed at once and the sample is usually removed from the table. If no satisfactory offers are obtained the grain remains for sale until a buyer is found. When demand is active all of the grain is frequently sold early in the trading period. When trading is slow some of the grain may not be sold during a trading period and the cars may have to be held over on track until the next day or it may be necessary to send the grain to storage elevators until the market is more favorable.

Railroads allow a period of free time in which a car of grain may be held on track. After this period the railroad makes a charge known as demurrage for the time the car remains on the hold or inspection tracks. The demurrage charge becomes progressively more as the time that the car is held lengthens. If the grain cannot be sold promptly it is usually moved to a warehouse or grain elevator and placed in storage.

Not all grain exchanges have trading floors. At some markets, particularly those on the Pacific coast, the dealers meet daily at the grain exchange and conduct what is known as a call market. At this call market some of the dealers make offers of definite quantities and

FIGURE 40.—A terminal market trading floor for cash grain.

grades of grain, stating the location of the grain and the time and condition for making delivery. These offers are recorded on the exchange's bulletin board. Other dealers make bids for designated quantities and kinds of grains. These bids also are placed on the bulletin board. Whenever any dealer is willing to pay the price at which a lot of grain is offered a sale is made and recorded. Likewise, when a dealer is willing to sell some grain at the price bid, a sale is made and officially recorded. It frequently happens that offers and bids during the call period are so far apart that no sales are made. The bid and offer prices, however, serve as a basis for bids sent out to country shippers after the close of the market and for trading later in the day when the dealers have returned to their offices.

When the local grain exchange or board of trade provides no trading floor and maintains only an administrative or executive office at the terminal market to receive cash and futures quotations from other terminals and to maintain inspection, weighing, and other marketing services, trading is carried on among dealers by telephone or personal calls. This type of trading may involve somewhat less expense but usually it does not provide as many services as are available at the more highly organized markets.

Weighing Services at Terminal Markets

Weighing services are provided at terminal markets by grain exchanges, traffic organizations, or State agencies. These services are

frequently coordinated with inspection services. Two types of weighing are usually available in the larger terminal markets. The first, commonly called track weighing, consists of weighing the entire car on railroad track scales and deducting the weight of the empty car to obtain the weight of the grain. The weight of the empty car is stenciled on it and this weight is used in determining the net weight of the grain when it is not convenient or possible to weigh the empty car at the same terminal market.

The second type of weighing, known as warehouse weighing, is usually employed when the grain is to be unloaded at a local mill, processing plant, or terminal market elevator. By this method the grain is weighed as it is unloaded, by passing it through a hopper or automatic scale located in the warehouse. When the weighing is completed, by either method, the correct weight is placed on a weight certificate which contains the car initials and number and other information for identification purposes. Weighing charges, including the furnishing of a certificate, range from $1 to $2 per car at the leading grain markets.

Grain Storage at Terminal Markets

Another important service available at terminal grain markets is elevator or warehouse storage. The storage capacity of public elevators in the leading terminal markets in 1948 was approximately 450 million bushels, not including storage elevators or warehouses attached to flour mills, oilseed crushers, or other processing plants. Because of the larger and more convenient handling facilities, better fire protection, hence lower insurance rates, grain storage at terminal markets is usually more economical than at country markets. Grain at terminal markets is also more readily available for delivery on cash sales and futures contracts.

Charges for storage at terminal market elevators differ slightly at the various markets, depending on the kind of grain, the kind of facilities available, and the trading practices. A uniform grain storage agreement was developed by the Commodity Credit Corporation of the United States Department of Agriculture in 1940 and in revised form is still in effect in 1949. This agreement provides for uniform storage charges for elevators and warehouses storing grain for the Commodity Credit Corporation. These charges vary somewhat by areas but may be considered representative for terminal markets in the central West. Under the agreement, effective through June 1949, charges for receiving grain into the storage elevator from cars or boats are 1¼ cents per bushel for all grains except grain sorghums, for which the rate is 2½ cents per 100 pounds. The storage charge is approximately 1¼ cents per bushel per month for most grains, with free storage after 6 to 7 months. The charge for loading the grain out of the storage elevator into cars ranges from ¾ cent per bushel for the principal grains to 1¼ cents per 100 pounds for grain sorghums. Additional charges for insurance and for conditioning the grain when necessary amount to about ¾ cent per bushel per month.

Functions and Equipment of Terminal Elevators

The function of terminal market grain elevators is about the same as that of country elevators; that is, to receive, store, and distribute

the market supply of grain. The principal difference is in the handling and storage capacity of the plants. A representative public grain elevator in a terminal market such as Kansas City, Minneapolis, or Buffalo can receive 5 to 20 thousand bushels of grain and load out 15 to 25 thousand bushels per hour. Storage capacity ranges from about a million to over 10 million bushels. The equipment in terminal market elevators is similar to that in country elevators but in most instances is larger, heavier, and has a much greater operating capacity.

Grain that arrives at terminal markets comes mostly by rail or water, although some is received by motortruck. Unloading equipment therefore is designed for the rapid unloading of railroad cars and boats. Two types of unloaders are in general use for railroad cars. One type consists of two power-drawn shovels or scoops attached to cables which draw the shovels with their loads of grain to the doorway of the car. Where this kind of equipment is used the car is placed over or beside a large hopper located slightly above ground level. Heavy iron bars across the top of the hopper protect the workmen and prevent any foreign object from falling into it. The hopper empties into elevators which carry the grain into the storage bins.

After the car has been placed at the unloading hopper or dump the grain doors are removed from one side of the car so that the grain can flow freely from the car into the hopper. The workmen who operate the power shovels get into the car, and by use of the shovels the grain is brought from the ends of the car to the door. In most terminal market elevators the shovels are pulled back into the car by the workmen and when loaded they are brought to the door by a cable and pulley arrangement powered by an electric motor. When their loads of grain have been discharged into the hopper the shovels are automatically released for reloading. In the newer models of this equipment, the shovels are pulled back into the car by motor power and then automatically are drawn to the doorway of the car. The operator has only to direct the operation by remote control through cables or ropes attached to the mechanism.

In some of the larger terminal market elevators the cars are run onto a section of track and are clamped securely to it. This track is mounted on a mechanism which, after the grain doors have been removed from one side, tilts the car toward that side so that most of the grain runs out quickly into the hopper. While the car is still tilted toward the hopper, one end of the car and then the other is raised until all the grain flows out by gravity. By this method the grain from a large car may be unloaded in a few minutes.

Unloading grain from boats requires equipment different from that employed in unloading cars. Two types are commonly used—the pneumatic unloader and the marine leg. The pneumatic unloader consists of a long spout or tube 8 to 10 inches in diameter, which is lowered into the hold of the boat. An air pump causes a powerful air suction in the tube which draws the grain from the boat through the tube and discharges it into the elevator or warehouse.

The marine leg consists of a steel elevator casing inside of which is a moving belt with cups attached. This steel casing is lowered into the grain in the boat. As it is pressed into the grain the cups on the

moving belt scoop up the grain and carry it to the top of the leg where it is discharged into a conveyor which carries it into the grain elevator. As the grain is removed the leg is lowered until it reaches the bottom of the boat. Since the bottom of the vessel usually is nearly flat it is necessary for workmen with shovels to scoop the grain from the sides and corners of the hold into the elevator boot from which it will be taken up by the moving belt. As each hold is emptied the marine leg is withdrawn and the boat is moved so that the leg may be lowered into another hold or compartment where unloading proceeds.

FIGURE 41.—Mechanism used at large terminal elevators for unloading entire carloads of grain.

Grain unloaded from cars or boats is usually weighed as it comes into the storage elevator. The scales, which are usually of the hopper type, are generally located on a working floor well toward the top of the elevator so that the grain after being weighed may be conveyed to the various bins without being re-elevated.

The weighers at public grain elevators, and at many private ones, are licensed by State inspection and weighing departments or by the local grain exchanges so that the grain may be officially weighed and certificated. To insure accuracy the weighers at the leading terminal markets are under the supervision of a weighmaster who checks their work and sees that the weighing facilities are in proper condition.

Most terminal grain elevators have facilities for cleaning and drying grain if such conditioning is necessary. This equipment, although of greater capacity, is similar to that described for country elevators. The charges for these services are generally established by the local

grain exchange or board of trade and are fairly uniform among the principal terminal markets. Anyone interested in the exact charges made at the markets for the various services should write to the secretary of the grain exchange or board of trade at the market for which the information is desired.

Terminal market elevators usually have equipment of large capacity to remove the grain from the bins and to load it into cars or boats. Grain is drawn from the bins onto large belt conveyors which carry it to large capacity belt and cup elevators, which in turn carry the grain to the top of the elevator, where it may be recleaned if desired, then weighed ready for loading into a car or boat. At most terminal

FIGURE 42.—Unloading grain from a boat into an elevator by use of a marine leg.

market elevators this loading is accomplished by gravity, and the force of the grain dropping from the scale or bin through the loading spouts is sufficient to carry the grain to the ends of the car or boat hold so that only leveling of the loaded grain remains to be done by hand. At the larger terminal market elevators a car can be loaded in a few minutes and a boat in a few hours.

Most grain loaded out of terminal elevators is inspected and certificated as to class and grade the same as when it arrived at the terminal. To sample grain loaded into boats, however, somewhat different equipment is used from that used in sampling cars. Samples are taken with a spout or pelican sampler by cutting the stream of grain as it flows from the loading spouts into the holds of the boat. The stream is cut as often as necessary to obtain samples that are

FIGURE 43.—Sampling grain with a pelican sampler by cutting the stream of grain as it flows from a loading spout into a boat.

representative of the different lots going into the boat. These samples are examined separately, and those which appear to be alike are mixed thoroughly and reduced to the proper size for grade and class determinations.

Grain Futures Markets

A number of the larger grain markets provide facilities for trading in grain futures. Futures trading in grain developed from time contracts, which, according to a study by an economist [5] of the United

[5] IRWIN, H. S. TIME CONTRACTS PRECEDED ORGANIZED FUTURES. Chicago Journal of Commerce, Chicago Board of Trade Centennial Number, April 5, 1948.

States Department of Agriculture, originated in Chicago in 1851 or about 20 years before organized trading in grain futures began. Time contracts were agreements between sellers and buyers of grain in which the seller agreed to sell at a specified price a certain quantity of grain to be shipped or delivered at a stated future time. These contracts were rather crude at first, but reached a rather high degree of standardization before organized trading was inaugurated.

The first rules regulating futures trading were passed by the Chicago Board of Trade in 1865. Since that time many changes and additions have been made in organization and rules of exchanges.[6] State laws were enacted regulating trading in futures, and in 1922 Congress passed the Grain Futures Act, which was approved on September 21 of that year. The act was amended June 15, 1936, to include cotton and other specified commodities and to incorporate other new provisions, and the title was changed to the Commodity Exchange Act. Additional commodities were added in 1938 and 1940.

To conduct futures trading, a board of trade must have complied with specific requirements and been designated as a contract market by the Secretary of Agriculture. Futures commission merchants accepting orders for the purchase or sale of futures on a contract market and floor brokers who execute orders on a contract market must be registered annually by the Secretary of Agriculture. The act is especially directed to the purposes of preventing manipulation and corners, outlawing certain abusive trade practices, safeguarding customers' funds, and requiring exchanges to extend members' trading privileges to cooperative associations of producers. It also authorizes a special commission, consisting of the Secretary of Agriculture, the Secretary of Commerce, and the Attorney General, to fix limits on the trading and positions of individual speculators.

Under the act the Secretary of Agriculture is authorized and directed to designate any board of trade or grain exchange as a contract market when it complies with certain requirements. Important among these are the following:

(a) It must be located at a terminal market where cash grain of the kind specified in the futures contracts is sold in sufficient volume as fairly to reflect the general value of the grain and the difference in value between the various grades.

(b) Provision must be made by the exchange in such detail as the Secretary of Agriculture may by regulations direct, for the filing of reports of all transactions either cash or future made upon the board and for the keeping of a permanent written record of transactions by the exchange or its members for a period of 3 years (or longer if directed), such record to be accessible for examination at any time by an authorized representative of the United States Department of Agriculture or the United States Department of Justice.

(c) Provision must be made by the exchange to prevent dissemination by the exchange or its members of false or misleading crop or market information.

(d) Provision must be made by the exchange to prevent manipulation of prices or a cornering of any grain by the dealers or operators on such exchange.

[6] HOFFMAN, G. WRIGHT. FUTURE TRADING UPON ORGANIZED COMMODITY MARKETS IN THE UNITED STATES. Univ. of Pa. Press. Philadelphia. 1932.

(e) The exchange must not exclude any duly authorized representative of a farmers' cooperative association which agrees to comply with the rules of the exchange. These rules, however, may not be so made or construed as to forbid the payment of patronage dividends by a cooperative association to its bona fide members.

In 1948 the following were contract markets for grain by designation of the Secretary of Agriculture: Chicago Board of Trade, Chicago Open Board of Trade, Minneapolis Grain Exchange, Duluth Board of Trade, Kansas City Board of Trade, St. Louis Merchants Exchange, Milwaukee Grain Exchange, Seattle Grain Exchange, Portland Grain Exchange, San Francisco Grain Exchange, and Los Angeles Grain Exchange.

Futures trading has become highly technical and involved. It consists essentially in the making of a contract in which a seller agrees to deliver a certain class and grade of grain, with provision for delivery of other classes or grades at differentials at a stated place at a designated future date, and the buyer agrees to accept and pay for such grain at time of delivery. Contracts are between members of the exchange and are subject to the rules and regulations of the exchange upon which the trade is made. Persons not members of the exchange who wish to trade in futures carry on their transactions through exchange members.

The futures contract is quite rigidly defined by the rules and regulations of the grain exchange and provides that: (1) The standard unit of trading be 1,000 or 5,000 bushels; (2) specified grades be deliverable; (3) the price paid be based on one or more deliverable grades; (4) the grain be delivered from an approved warehouse; (5) the grain be graded by licensed inspectors and weighed by official weighers; and (6) the grain be delivered during a specified month. The contract also stipulates the seller's option as to the grade and day of the month of delivery.

Trading in futures may be utilized by farmers, country grain shippers, flour millers, and others as an insurance against losses incident to market changes. If a farmer, for example, believes that the price of wheat at or before harvest is more favorable than it will be later, he may sell at the current price, in the futures market for later delivery, the quantity of grain he expects to market. When he ships his grain to market and sells it he buys back the futures contract. If the market has declined, the profit he makes on the futures transaction will offset the loss he has sustained on his cash grain so that in effect he receives for the cash grain the price at which he sold the futures contract, less the commission charge.

The country elevator operator may use futures contracts as an insurance against price changes during the time that his grain shipments are moving to market. The procedure would be similar to that of the farmer, in that the operator would sell on the futures market the quantity of grain for which he desired protection against a price decline. When his grain reached the market and was sold he would buy back the futures contract with which he had hedged his operation. Any decline which may have occurred in the cash market would be offset by the gain he had made in the transaction in futures.

Dealers and processors usually sell futures to protect their inventories of cash grain, or their purchase commitments, against losses

due to market changes. Many processors, however, who have sold products for later delivery at fixed prices, buy futures to insure against price changes that may occur before they can acquire the cash grain. Buying or selling futures contracts as an insurance against losses from price changes is commonly termed hedging.

Hedging transactions in futures markets are carried on about as follows: A dealer or processor who has purchased or has on hand stocks of grain which he wishes to insure against losses from market changes, sells futures contracts for an equivalent quantity of grain to be delivered in some specified future month. When the dealer sells any part of his grain or the processor sells the product manufactured from his grain, each of them buys back his futures contract in an amount equal to the cash sales of grain or grain products. If the

FIGURE 44.—Futures trading floor and "pits" in which trading in grain futures is carried on.

market had declined between the time the grain was purchased and the time the grain or its products were sold the dealer or processor would have sustained a loss had he not sold a futures contract as a hedge. However, because of the market decline, each was able to buy back his futures contract at a profit which would approximately offset the loss in his cash transaction. Had the market advanced the gain on the cash sales would have offset the amount lost in buying back the futures contracts.

Millers or other grain processors who, as a business policy, sell their products at a fixed price for delivery ahead of the time that they can obtain the grain or in quantities in excess of the grain storage capacity of their plants, usually buy grain futures contracts as insurance against losses which might result from an advance in the grain market

before they were able to purchase their full requirements. In such transactions any loss caused by an advance in grain prices would be mostly offset by the gains made in the sale of the futures contracts. Had the grain market declined, the loss in futures transactions would have been offset in most part by the gain made on the cash grain purchases. Hedges in futures, however, do not always provide full protection against price changes for the reason that cash and futures prices frequently do not advance or decline equally. The purchase or sale of a futures contract will fail as a means of full protection against losses, to the extent of any change that may occur in the spread between cash and futures grain prices.

All transactions on futures markets must be made by or through members of the grain exchange or board of trade, and there is a commission charge for this service. These charges or commission rates are established by the exchanges and may vary somewhat between markets. Rates in 1948 ranged mostly between $3 and $4 per 1,000 bushels for nonmembers. Rates for members were one-half or two-thirds of this amount.

In addition to commission fees, traders must make a deposit of money called a margin with the commission merchant to assure fulfillment of the contract. Margin requirements, which are established by the grain exchange, vary from time to time, depending largely on the state of the market. The amount of the margin is returned to the trader when the transaction has been completed and the account closed.

How Futures Trading Is Conducted

Anyone wishing to buy or sell a futures contract must do so through a commission merchant registered with the Secretary of Agriculture as a futures commission merchant. The procedure, in broad terms, is as follows: A person desiring to purchase or sell a grain futures contract, either in a hedging operation or for speculation, selects a qualified brokerage or commission firm to handle his account. The trader must first make arrangements for establishing satisfactory credit for his operations. This is usually done by depositing with the brokerage firm the required margins to guarantee the fulfillment of the contracts.

When a trader desires to place an order to buy or sell a futures contract, he usually informs the brokerage firm by telephone or telegraph concerning the futures (designated by the delivery month) in which he wishes to trade, the quantity to buy or sell, and the price at which to buy or sell. When the order is received at the broker's office it is recorded, time-stamped, and immediately transmitted by direct private telephone to the broker's telephone clerk located in a booth on the exchange floor. The telephone clerk records the order on a card and passes it to the broker's representative in the trading pit. The pit or floor broker immediately begins to offer to buy or sell the futures contract in accordance with the wishes of the trader who placed the order. To do this he enters the trading pit where other brokers are also offering to buy or sell futures contracts. The trading pit consists of a concentric series of steps leading down to a common center. This arrangement makes it possible for the traders to see and hear each other

more clearly. In addition to calling out their offers the brokers also use hand signals to indicate the quantities and prices.

When the broker succeeds in selling or buying the futures contract for which he has an order, he passes the information to the telephone clerk who relays it back to the broker's office where it is recorded in the customer's account.

Settlement and Clearance of Trades in Futures

When a grain broker purchases a futures contract for his customer, he buys from another broker who is selling such futures for his customer. Since it is not desirable for brokers to make known the names of their customers, brokers or brokerage firms treat each other as principals in their futures transactions, despite the fact that each may be acting as an agent for a customer. During a day's trading each broker makes many sales and purchases. An average day's trading in wheat alone on the Chicago Board of Trade would result in about 7,000 contracts.

These trades link together the body of brokers into a network of contractual relations. The deposit of margins for each trade complicates the problem. If each outstanding contract would have to be carried on the broker's books until delivery date along with the daily additional trades, and if each buying and each selling broker would be required to deposit margins for each transaction, trading would be greatly impeded, if not stopped altogether. This problem of completing and adjusting commitments was met soon after trading in futures became an important market function, by the establishment of a clearing house.

The clearing house, which is similar to a bank clearing house, is a corporation, separate from the grain exchange or board of trade, established to settle, adjust, and clear contracts for the purchase and sale of commodities; to adjust and clear money balances; and in other ways to handle the business of the exchange. This corporation has a governing board, a president, vice president, secretary, and treasurer, with a manager charged with the immediate direction of the work of the clearing corporation.

The function of the clearing house is to make the many adjustments and settlements required for satisfactory trading in futures contracts and to safeguard the interest of traders. In earlier operations clearing houses aided brokers in confirming their sales and in adjusting money balances growing out of cleared transactions. Later they enlarged their functions to assume actual direction in the clearing of trades in the daily adjustment of margins. All trades made by brokers (members of the clearing house) are reported daily to the clearing house. Trades which call for delivery of grain by warehouse receipts are also directed by the clearing house.

These simple illustrations show the essential features and operations of futures trading in grain, but many operations are more involved and frequently are entirely for speculative purposes. Information can be obtained direct from the grain exchanges which have futures markets and from publications on the subject of futures trading. One such publication is by G. Wright Hoffman, at one time a con-

sulting economist of the Commodity Exchange Authority of the United States Department of Agriculture.[7]

Price-Making on Grain Exchanges

Grain exchanges provide facilities for the important function of price-making. This applies both to the cash and futures markets. How cash sales of grain are made has already been described, but there is the further problem of making price information available to traders on the exchange, to farmers who have grain to sell, to country elevator operators who have consigned grain to the markets, and to feeders, feed manufacturers, millers, and other processors who want to buy grain.

Information on cash grain prices is first made available to interested persons and agencies when the dealer or commission merchant sells on the exchange floor the grain represented by the samples on the table. Exchange rules at most markets provide that when a sale is made information about it must be reported promptly to a designated officer of the exchange, who will post the price and related data on a bulletin board where it may be seen by all traders, by representatives of newspapers or trade publications, by Government representatives, and by all others who have interest in these prices and who have access to the trading floor. In addition to the price, a notation is posted concerning the kind, class, and grade of grain and other information that may be necessary to explain the quotation adequately. At most markets the cash prices are published at the close of the day's trading in an official or semiofficial market bulletin which is delivered by mail or messenger to traders and others who have subscribed to it. Local newspapers also usually publish the figures promptly and many radio stations broadcast the prices as a public service. Government and private market news services also use and disseminate this price information.

The recording and dissemination of quotations for grain futures are much more involved than for cash grain. In the first place trading in futures is rapid and is accompanied by more or less confusion. No grain samples are involved, since the trading is in contracts and not in actual grain. When a trader or broker makes a purchase or sale of a futures contract he reports the transaction immediately to the price reporter who is stationed on a raised platform at the side of the trading pit where he can see or hear each transaction.

The recorder makes a record of the purchase or sale and hands it immediately to a telegrapher or teletypist who transmits it promptly to an exchange employee who in turn records the price on a large blackboard located on one side of the trading floor and elevated so that it may be seen by the pit traders and by the commission men in the cash market. The quotations are recorded also on the tape of teletype machines located at vantage points on the trading floor. A further wide distribution of the prices is made by commercial news services and brokerage houses, which through a network of telegraph communications cover the entire United States and extend to foreign markets.

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[7] See footnote 6, p. 58.

Commercial telegraph companies, for a regular charge, furnish country elevator operators and others at stated intervals grain futures quotations from the market of the customer's choice. Grain brokerage firms maintain offices in all important cities where market quotations are received continuously through the facilities of a teletype or a narrow tape ticker. These quotations are available to the firm's customers and to others who may be interested in them.

In addition to the information service on cash and futures prices, grain exchanges or boards of trade also provide facilities for the collection and dissemination of other types of market information, including crop conditions, both foreign and domestic, statistical data on stocks, movement and utilization, and comments as to trading activity and state of the market. The compilation and dissemination of this material are usually handled by private commercial news agencies, but at some markets the exchange sponsors or handles this work. The market information which emanates from the grain exchanges and the dealers' evaluation of this information are important factors in establishing prices.

The United States Department of Agriculture conducts a market news service on grain to provide growers, shippers, and other agricultural interests authentic and timely information on crop conditions, production, market movement, stocks, utilization, and other factors which influence the market. This information is available without charge to those who have need of it. The grain market reviews and summaries issued by this service may be obtained on request from the Production and Marketing Administration, Department of Agriculture, Washington 25, D. C.

Traffic Department and Services Rendered

Most grain exchanges maintain traffic departments which render valuable services to their members. These services in turn are beneficial to shippers and growers. The principal function of the traffic department is to provide service and information relating to freight rates, transit arrangements, and rules and regulations governing transportation and matters affecting transportation. Because of the narrow margins that normally prevail in grain marketing, transportation charges and transit arrangements are important market factors and may limit the area from which grain may be shipped profitably to a market or the area in which the market may distribute its grain.

Traffic departments are usually headed by a traffic commissioner. It is his duty to keep abreast of developments in the transportation field and to determine to what extent they may affect the operation of the market in which he is located. He handles, for exchange members, requests for changes in freight rates or transit arrangements. He appears and presents before the Interstate Commerce Commission or State regulatory bodies, evidence in cases relating to changes in freight rates that may affect the grain interests.

The traffic department has the further responsibility of maintaining a supply of cars adequate for the needs of the market; also, of seeing that the market receives its proportionate share, particularly in times of car shortages. In some markets the traffic and inspection departments are combined and the traffic commissioner has charge of the sampling and inspection service at the market.

Disposition of United States Grain Supply

The United States produces more grain than any other country in the world but uses most of it at home for food and feed, table 5.

TABLE 5.—*Distribution of United States grain supplies, by years 1942–46, and 5-year averages, 1935–39 and 1942–46*

WHEAT

Year [1] and average for 5-year period	Used for feed and seed	Milled or processed for food	Used in production of alcohol	Used in starch manufacture	Exported as grain	Total distribution (imports not included)
	1,000 bu.	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*
1935–39 av	202, 239	486, 440	68		39, 181	727, 928
1942–43	364, 204	555, 956	54, 342		6, 757	981, 259
1943–44	438, 339	581, 519	107, 527		18, 770	1, 146, 155
1944–45	333, 153	605, 715	82, 295		76, 323	1, 097, 486
1945–46	391, 337	601, 746	20, 971		273, 262	1, 287, 316
1946–47	274, 001	696, 439	44		198, 977	1, 169, 461
1942-46 av	360, 206	608, 275	53, 036		114, 818	1, 136, 335

CORN

Year [1] and average for 5-year period	Used for feed and seed	Milled or processed for food	Used in production of alcohol	Used in starch manufacture	Exported as grain	Total distribution (imports not included)
1935–39 av	1, 707, 140	75, 808	24, 572	74, 579	43, 566	1, 925, 665
1942–43	2, 661, 719	93, 244	41, 584	128. 002	4, 805	2, 929, 354
1943–44	2, 587, 044	93, 139	10, 482	120, 934	9, 997	2, 821, 596
1944–45	2, 444, 735	94, 757	36, 986	124, 589	16, 611	2, 717, 678
1945–46	2, 492, 370	84, 647	27, 513	111, 732	19, 874	2, 736, 136
1946–47	2, 421, 135	92, 171	55, 143	143, 457	126, 739	2, 838, 645
1942–46 av	2, 521, 400	91, 592	34, 342	125, 743	35, 605	2, 808, 682

OATS

Year [1] and average for 5-year period	Used for feed and seed	Milled or processed for food	Used in production of alcohol	Used in starch manufacture	Exported as grain	Total distribution (imports not included)
1935–39 av	999, 196	28, 947			3, 276	1, 031, 419
1942–43	1, 252, 370	44, 000			278	1, 296, 648
1943–44	1, 146, 566	44, 000			228	1, 190, 794
1944–45	1, 076, 665	46, 000			250	1, 122, 915
1945–46	1, 410, 086	50, 000			18, 291	1, 478, 377
1946–47	1, 442, 996	50, 000			20, 331	1, 513, 327
1942–46 av	1, 265, 737	46, 800			7, 875	1, 320, 412

RYE

Year [1] and average for 5-year period	Used for feed and seed	Milled or processed for food	Used in production of alcohol	Used in starch manufacture	Exported as grain	Total distribution (imports not included)
1935–39 av	26, 453	6, 712	8, 323		1, 670	43, 158
1942–43	32, 580	8, 770	2, 089		15	43, 454
1943–44	30, 979	9, 210	4, 510		110	44, 809
1944–45	20, 059	8, 181	10, 363		2, 741	41, 344
1945–46	11, 722	7, 638	8, 316		6, 165	33, 841
1946–47	8, 488	5, 514	4, 235		573	18, 810
1942–46 av	20, 765	7, 863	5, 903		1, 921	36, 452

[1] Year beginning July 1 for wheat, oats, rye, and barley and October 1 for corn.

TABLE 5.—*Distribution of United States grain supplies, by years 1942–46, and 5-year averages, 1935–39 and 1942–46*—Continued

BARLEY

Year [1] and average for 5-year period	Used for feed and seed	Milled or processed for food	Used in production of alcohol	Used in starch manufacture	Exported as grain	Total distribution (imports not included)
	1,000 bu.	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*
1935–39 av	157, 979	[2] 3, 594	61, 096		9, 542	232, 211
1942–43	324, 460	[2] 5, 500	78, 994		418	409, 372
1943–44	276, 322	[2] 6, 128	84, 644		404	367, 498
1944–45	156, 548	[2] 5, 506	94, 149		775	256, 978
1945–46	211, 723	[2] 6, 806	81, 838		2, 967	303, 334
1946–47	159, 654	[2] 7, 322	87, 683		10, 625	265, 284
1942–46 av	225, 741	[2] 6, 252	85, 462		3, 038	320, 493

[2] Barley equivalent of malt used as food but does not include pearled barley or barley flour, for which official data are not available.

Wheat Uses

Wheat, the principal food grain of the United States, reached a record production of nearly 1,365 million bushels in 1947. The annual supply during the 5-year period 1942–46 averaged well over 1.1 billion bushels. About a third of this supply was used for feed and seed and about a tenth was exported as grain. The remainder of about 608 million bushels, or slightly more than 50 percent of the total, was milled into flour for human consumption. About a sixth of this flour was exported and the remainder was consumed in the United States.

Rye is also an important food grain, but the quantity used for food in the United States averaged only about 7¾ million bushels annually during the 5 years 1942–46. Nearly 6 million bushels were converted into alcohol, about 21 million bushels were used for feed and seed, and around 2 million bushels were exported.

Long before the dawn of history cereals formed an important article of food for the human race. At first these grains were used without grinding or cooking. It apparently was discovered very early, however, that both from the standpoint of mastication and flavor grain is much improved by grinding and cooking or baking, so that the first milling process came soon after man began the cultivation of the soil.

At first the grain was merely broken into coarse fragments by placing it in a hollow stone and pounding it into meal with another stone. Later two stones with roughened grinding surfaces were placed together and one was rotated on the other. The grain was crushed or ground between the stones. An improvement on this crude method was the grooving of the grinding surfaces and the flattening out of the stones. Thus the use of millstones for grinding grain dates back to very early ages.

The use of millstones for grinding flour was universal until the close of the eighteenth century and is still common in small country mills. The millstones were made of buhrstone, a form of silica, as hard as flint

but not so brittle. They were usually 4 to 6 feet in diameter and each consisted of a number of pieces strongly cemented and bound together with iron hoops. The grinding surface of each stone was furrowed or grooved. One side of each groove was cut perpendicular and the other was inclined toward the surface of the stone. The lower stone was firmly fixed and the upper stone was made to revolve. The clean grain was fed to the millstones through a hopper with a valve to regulate the supply. The millstones were enclosed and the flour passed from the outer edges of the millstones through a spout to conveyors which carried it to machines which separated the flour from the bran and other offal.

The next development of the milling process was the substitution of iron rollers for stones to perform the grinding process. Iron rollers were first used in Hungary about 1840 to grind wheat, and under the name of the Hungarian System spread rapidly throughout Europe. E. N. Lacroix, a French miller, invented a system of roller milling similar to the Hungarian System in 1868 or 1870 and installed it at one of the great flour mills at Minneapolis. The essential feature of the new process was the substitution, for a single grinding between one set of millstones or rollers, of a succession of grindings between several sets of rollers. This process is still in use, although many improvements and refinements have been made during the past century.

The essential equipment in modern flour milling is shown in figure 45. As the wheat enters the mill it is weighed, cleaned of foreign material, washed and dried, scoured, and placed in tempering bins to complete its conditioning for milling. In the milling process the first set of rollers, which are corrugated, breaks the bran coating on the grains of wheat so that the bran and germ may be separated from the berry. The ground material is passed into a scalper which removes most of the bran. The material from which the bran has been removed then passes through the second and third set of rollers for further grinding. After each grinding the material passes through a scalper or sifter to remove more of the bran.

After the bran has been removed the main product is passed through a grading reel where the flour is separated from the coarser material by sifting through a bolting cloth. The coarse material is then reground through smooth reduction rolls. After each grinding, it is bolted, or sifted, to remove any material other than flour. The flour is then ready for market and is placed in the flour bin to be packed into bags for shipment.

Approximately 2,100 flour mills operated in the United States in 1947 and produced a record quantity of 302,400,000 bags (100 pounds) of flour from 694,700,000 bushels of wheat. In 1946 flour production was placed at 278,900,000 bags from 625 million bushels of wheat.

Of the 1946 flour production 45 million bags were exported, leaving about 233,900,000 bags for domestic use. Prewar flour exports averaged only 5,300,000 bags annually for the period 1935–39. In addition to the 2,100 commercial mills there were quite a few small custom mills which produced flour, mostly for local consumption in rural areas.

Another important product of wheat milling is the offal, consisting of bran and middlings or shorts. These are valuable feeds, and in

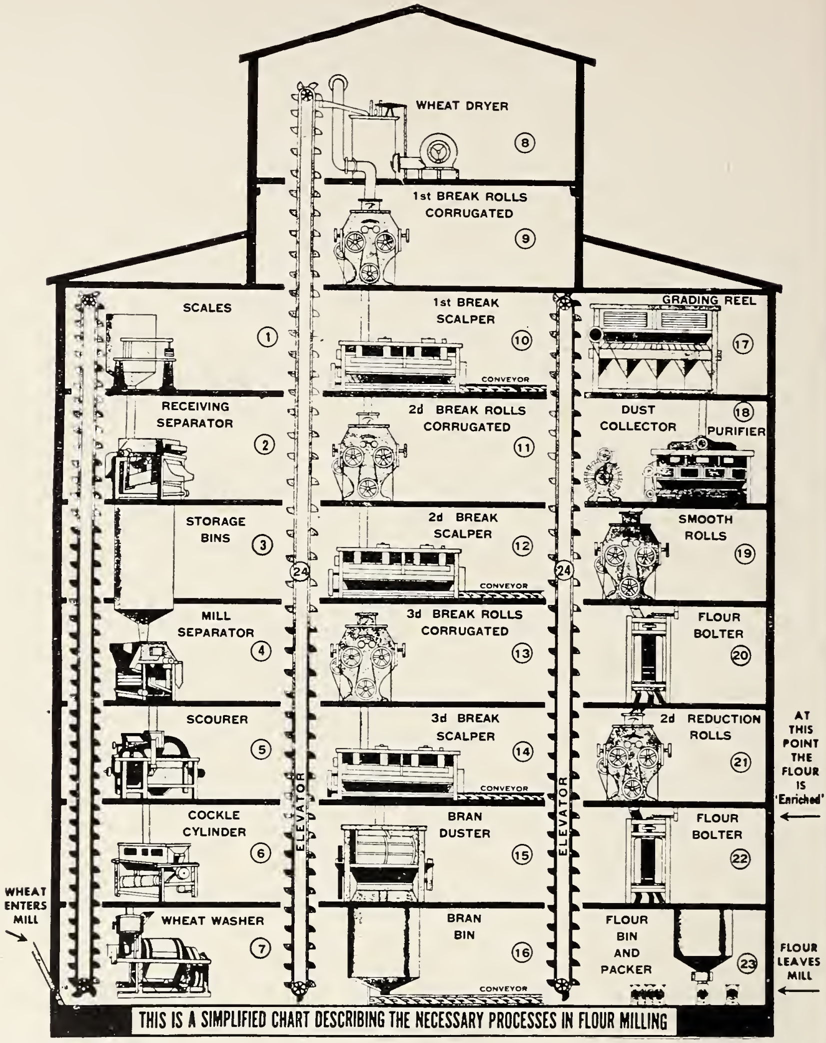

FIGURE 45.—Diagram of a modern flour mill showing essential machines and their relative positions.

recent years the demand for them has exceeded the supply. Bran is the coarse outer covering of the wheat kernel, which is separated from it in the usual process of commercial milling. Middlings consist mostly of fine particles of bran, wheat germ, and very little of other fibrous portions of the kernel. Shorts are quite similar to middlings. This term is more generally applied to the offal from hard winter wheat, while middlings are more commonly applied to spring and soft winter wheat offal. On the Pacific coast and in some other areas the bran and middlings or shorts are run together as they come from the mill. This product is called millrun or wheat mixed feed.

The quantity of offal obtained from a lot of wheat depends on the quality of flour produced. The higher the grade of flour the greater is the quantity of offal. In general, however, 38 to 39 pounds of offal result from the production of 100 pounds of flour at an extraction rate of 72 to 73 percent. Because of the variation in milling practices no reliable data are available as to the percentage of the offal that is bran and the percentage that is middlings or shorts.

During the 5 years 1942–46, the production of wheat offal or millfeeds averaged more than 5¼ million tons annually. About 85 thousand tons of millfeeds on an average were imported annually. These imports came principally from Canadian wheat ground in bond in United States mills. The flour from this wheat was mostly shipped abroad but the millfeeds were brought into the United States by the payment of an import duty. When the net imports are added, the quantity of millfeeds available for use in the United States during the 5-year period 1942–46 averaged nearly 5½ million tons annually. The largest quantity ever produced in one crop year, July 1 through June 30, was in 1946–47 when the total was 5,778,000 tons. The quantity available for domestic use that year was 5,836,000 tons. The price of this feed at 10 leading markets during the 1942–46 period averaged about $45.50 per ton, which would indicate a total annual average value of 250 million dollars for the wheat offal produced during that period.

TABLE 6.—*Wheat millfeed production and net supply, 1942–46*

Year beginning July 1 —	Production	Imports	Exports	Net supply
	1,000 tons	*1,000 tons*	*1,000 tons*	*1,000 tons*
1942	5, 075. 9	137. 2	0. 9	5, 212. 2
1943	5, 446. 8	70. 2	1. 8	5, 515. 2
1944	5, 519. 1	53. 6	2. 4	5, 570. 3
1945	5, 045. 0	106. 1	1. 1	5, 150. 0
1946	5, 778. 1	61. 5	3. 7	5, 835. 9
5-year average	5, 372. 9	85. 6	2. 0	5, 456. 5

Utilization of Corn

Corn has been the principal grain crop in the United States since the first settlers found it being grown by the American Indians. When the 1839 census was taken, corn production was found to total nearly 378 million bushels as compared with only 85 million bushels of wheat. Corn production passed the billion bushel mark in 1870 and reached nearly 3.7 billion bushels in 1948, a record crop to that date. The distribution of corn as grain reached more than 2.9 billion bushels during the 1942–43 season. The 1935–39 prewar distribution averaged 1.9 billion bushels annually.

Most of the corn produced in the United States is used for feed. During the period 1942–46 over 90 percent of the crop harvested as grain was used for feed, about 4½ percent was processed for starch, 3½ percent was milled for food, and 1½ percent was used in the pro-

duction of alcohol. Only about 1½ percent of the supply was exported during that period despite the larger than normal quantities shipped overseas for relief purposes.

As is indicated by the distribution figures, the next largest use of corn after feed is for the production of starch and its byproducts—sugar, sirup, and oil. The use of corn for starch manufacture increased around 100 percent from 1918 to 1948. Consumption of starch was particularly heavy during the war years, and a record total of approximately 143 million bushels of corn was used in wet-process grinding for starch in 1946–47. The prewar 1935–39 average was only 75 million bushels a year.

Processing of Corn Into Starch

Starch is obtained by what is known as the corn wet-milling process. As a first step in this process the corn is placed in tanks, where it is soaked or steeped for about 2 days in warm water that has been treated with a small amount of sulphur dioxide to prevent fermentation during the soaking. After the corn has been steeped it is put through machines called attrition or degerminating mills, which break the kernel so as to free the germ but not crush it. When the corn comes from the degerminating mills it is washed into tanks called germ separators. The oil-bearing germs, being lighter, float to the top and are skimmed off at the end of the tank.

After the germ is removed, the remainder of the corn kernel is ground between millstones to separate the starch granules and gluten from each fragment of fiber and hull. The grinding is done in a buhr mill, which was described under wheat milling. The wet mash from the buhr mills is forced through a series of reels and shakers, the sides of which are covered with nylon. The mash enters at the upper end of the reel and as the reel revolves, water washes the gluten and starch through the nylon covering of the reel, but the particles of the hull and fiber which cannot pass through move toward the lower end of the reel where they are discharged.

The mixture of starch and gluten from the shakers flows onto starch tables, which are really flat-bottomed troughs about 2 feet wide and sometimes as long as 120 feet. They are slightly tilted so that the mixture will flow very slowly toward the far end. The starch granules are heavier than the gluten and settle on the bottom of the table or trough, while the gluten flows off at the end of the table. These starch tables are rapidly being displaced by mechanical separators, discharging the lighter gluten at the top and the heavier starch at the bottom of the machine, on the same principle as cream separators. The starch is washed to free it from all gluten particles and is then ready either for drying and preparation for market or for further processing into dextrin, sirup, or sugar.

Dextrins may be described roughly as roasted starches. More than 100 different kinds or brands of dextrins are made from cornstarch. The starch is changed to dextrin in round metal tanks, open at the top and equipped with a slowly moving scraper which keeps the material from sticking to the sides and bottom while it is being heated. The temperature during the heating is carefully controlled. The time of heating varies with the kind of dextrin to be made. The finished dextrins are powders that vary in color from pure white to a light yellow.

Corn sirup is made by heating starch in a closed tank called a converter. The starch is first mixed with water and with a weak solution of hydrochloric acid. The acid is put into the converter first and heated; the starch is fed in gradually. When the conversion has reached the right point it is stopped by opening a valve and letting the pressure within the converter force the liquid upward into a neutralizing tank on a higher level where the acidity is neutralized by adding a measured amount of sodium carbonate or soda ash. After it is neutralized the sirup is filtered through bone char or charcoal or other types of filter and is evaporated to the proper consistency. These steps in the process are similar to the method cane sugar refiners use in preparing the juice of cane for sugar extraction.

To make sugar, cornstarch is treated in converters under heat and pressure in the same manner as in sirup manufacture, except that the time of conversion is much longer, the starch being changed almost entirely into dextrose. Two general types of sugars are made—crude and refined. In making crude sugars the liquor is poured into special tanks and is cut into large slabs as soon as it has partially crystallized. The slabs are aged to allow fullest crystallization. Sugars of this type are of light brown color and contain 70 to 80 percent of dextrose.

Refined sugar is made by crystallizing the finished sirup in huge cylindrical tanks provided with a special agitator which moves slowly through the crystallizing liquid to prevent the forming of solid lumps of crystals. This crystallizing takes from 6 to 10 days. The final step takes place in centrifugals which filter the last remnants of molasses from the crystals and leave a white refined sugar which is almost pure dextrose.

The germs from the corn kernel are dried and ground into fine particles which are put through expellers to remove the oil. The residual is called oil cake and is later ground into oil-cake meal for use as livestock feed. The oil is refined and after being purified and refiltered yields a crystal-clear corn oil which is used in making cooking and salad oils and in the manufacture of soap and glycerine.

The gluten which flows from the end of the starch tables and the hulls which were removed by the reels and shakers are dried and ground into meal and marketed for livestock feed. Gluten feed and meal production reached a record of slightly over a million tons in 1946–47. The 1935–39 prewar average production was approximately 565,000 tons.

Use of Corn for Alcohol Production

The use of corn in the production of alcohol or distilled spirits during the prewar period 1935–39 averaged about 25 million bushels. During the war period, the increased need for industrial alcohol caused an expansion of distilling operations, so that more than 55 million bushels of corn were used in the peak year 1946–47. The average annual use during the 5 years 1942–46 was slightly more than 34 million bushels. This, however, was only 1.5 percent of the average annual corn supply during the period.

Distilling is a comparatively simple process and apparently was discovered in very remote times. The various steps in the production of alcohol or distilled spirits from corn in the order in which they

occur in the distilling process are as follows: First the grain is cleaned; then it is ground so that it is granulated but not too fine. Stone buhr mills, roller mills, attrition or hammer mills may be used for grinding, but roller and hammer-type mills are now most generally used. The quality of the product can be more easily controlled when ground in these types of mills. The grinding is necessary to make the starch inside the grain more readily available. It is the starch from which alcohol is made, but it must first be turned to sugar.

The process by which starch is turned into sugar is termed fermentation. This is brought about by the addition of malt to the ground grain after it has been converted into a mash by adding water and cooking 1 or 2 hours. The malt is produced by sprouting and drying barley (other grains may also be used), then removing the sprouts and grinding the malted grain. The sprouting activates the diastase in the malt. This diastase when added to the mash, after it has been cooled somewhat, turns the starch into sugar.

After the starch has been converted to sugar the mash is transferred to fermenting tubs or closed fermenters. Here yeast which has been carefully prepared is added. This is the agent that converts the sugar to alcohol. During fermentation, which requires 3 to 4 days, certain chemical reactions occur. Among the chemicals produced are carbon dioxide, used in the production of "dry ice," and ethyl alcohol. At the end of the fermentation period the "beer," which is the name given the product at this stage of the process, is discharged into the beer well or reservoir, from which the product is pumped to the still for distillation.

There are two types of stills in general use—the charge or chamber still and the continuous still. The chamber still is a vertical cylinder built of heavy copper and usually divided into three chambers. When the distillation of the beer in the lower chamber is completed the spent grain is discharged from the still and the batches in the upper chamber are dropped down to take its place. A new charge of beer is then placed in the upper chamber and the process is repeated.

The continuous still is also a vertical cylinder but is divided into seven or eight sections. The beer enters from the top of the still and moves steadily but slowly downward. Its movement is regulated by perforated plates in the cylinder. The steam or vapor, forced upward through the perforations from the lower sections of the still, allows the beer to move down at a rate that will complete distillation by the time it reaches the lowest section or slop chamber, where the spent material is discharged continuously.

In both types of stills the heat which causes the alcohol to vaporize is applied in the form of steam. The vapor as produced rises to the top of the still, where it enters the condenser. The condenser consists of a coil of pipe surrounded by cold water. As the vapor passes through the coil it is condensed into a liquid and becomes distilled spirits or alcohol, depending upon the extent of its conversion and distillation. The finished product is placed in tanks in the cistern room from which it is drawn for barreling and aging or for commercial use as alcohol.

The spent grains are either disposed of as slop or are dried to produce distillers' dried grains. The quantity dried for feed averaged 434,000 tons of dried grains annually during the 5 years 1942–46.

Prewar production during 1935–39 averaged 187,000 tons. The distilling industry is concentrated principally in the States of Illinois, Kentucky, Maryland, and Pennsylvania.

Dry Milling of Corn

Corn used directly for human food is usually in the form of meal, hominy, or grits. Only about 3½ percent of the corn supply is used in the production of these foods, but this amounted to a little more than 90 million bushels of corn annually during the period 1942–46.

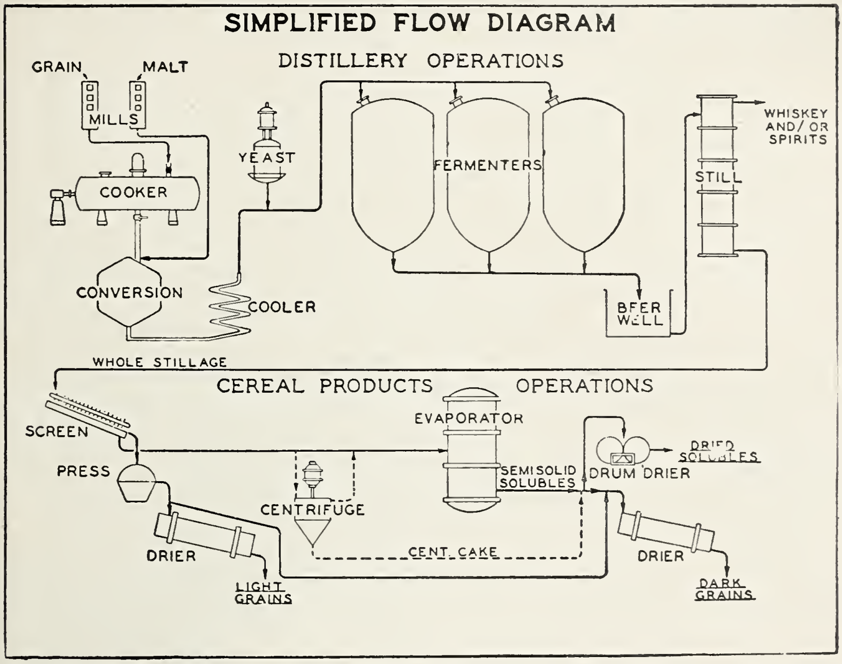

FIGURE 46.—This chart or diagram shows the essential steps in the production of alcohol or distilled spirits and the different types of equipment used.

Corn is ground into meal for human food by two general methods, commonly designated as "old process" and "new process." Old-process meal is also known as water-ground, because most of the mills making this type of meal were formerly operated by water power.

By the old process the corn is ground to a coarse meal between millstones run slowly at a low temperature. In the smaller mills the meal is frequently not bolted. In the larger mills from 4 to 6 percent of the coarser particles of the meal is bolted or sifted out. This type of meal, therefore, is essentially a whole-corn product, since it contains the germ which gives it a rich flavor but causes the meal to deteriorate rapidly. Some of the larger mills dry the corn before grinding and this improves the keeping quality of the meal.

New-process corn milling, which constitutes the larger part of the processing, is usually performed with steel rollers similar to those used

in the milling of wheat. The purpose of the milling is to remove the bran from the germ and to recover the endosperm in the form of hominy or corn grits, coarse meal, fine meal, or corn flour.

Dent corn is used almost entirely for the production of corn grits and corn meal, and both white and yellow dent corn is milled. In the milling process the shelled corn is first passed over magnetic separators to remove pieces of iron, nails, and other such metal objects. It is thoroughly cleaned by sieving, scouring, blowing, and washing. The cleaned grain is then tempered or conditioned by the addition of water to a moisture content of from 21 to 24 percent. This is done in order to toughen the bran. The corn is allowed to stand some hours in the tempering bin, after which it is passed through a short conveyor, where warm water or sometimes steam is added to loosen the bran and the germ.

The corn is degerminated by passing it through a degerminator, which consists of a horizontal cone-shaped drum, covered with small steel projections and revolving about 700 revolutions per minute within a metal housing. The housing is also studded with similar steel projections. As the corn passes from the small to the large end of the germinator most of the bran and germ are freed from the main kernel or endosperm, which is broken into two or more pieces. The material discharged from the degerminator is dried and cooled, and then passed through a separator or grading reel which separates the fine particles and grades and polishes the larger fragments into four sizes.

From the grading reels the broken corn is passed through a separator which removes the loose bran by means of a strong current of air. The coarse particles of corn which are to become commercial grades of hominy are then passed through a hominy polisher which consists of a revolving cylinder surrounded by a perforated screen. The polished hominy is regraded and the fine particles removed. It is then ready for commercial use.

The material that is to be made into grits or meal is reduced by grinding to the quality or type of grits or meal desired. The modern corn mills are designed in such a way that grits of any particular size may be taken off or they may be subjected to further grinding and sifted to produce meal and flour. The germ which has been removed is ground, tempered with steam, and passed through a press or expeller which extracts the oil.

In the milling of corn for grits or meal by the degerminator process the yield of the finished product consists of about 52 percent of grits, 8 percent of meal and flour, 35 percent of offal, known as hominy feed, and about 1 percent of crude corn oil. When the corn is not degerminated, a yield of about 72 percent of meal and about 28 percent of feed is obtained.

Oats Uses

Oats, the third most important grain of the United States, is used principally for feed. Small quantities are used for the manufacture of breakfast foods and insignificant amounts are exported. During the 5-year period 1942–46 the annual utilization or disappearance of oats averaged 1,320 million bushels. Of this quantity 1,266 million bushels, or 96 percent, on an average, was used for feed and for seed for the next crop. Seed requirements were a little over 100 million

bushels. During the prewar years 1935–39, disappearance averaged 1,031 million bushels, of which nearly 1,000 million, or 97 percent, was used for feed and seed.

Exports of oats in the prewar years 1935–39 averaged only a little more than 3¼ million bushels annually, which was only 0.2 percent of the total supply. Exports in 1946–47 were the largest in 20 years as a result of postwar shipments for relief purposes. They totaled a little more than 20 million bushels, but were still only a little over 1 percent of the total supply.

The use of oats for food in the United States is relatively small and comprises only about 3.5 percent of the total. During the war years between 45 and 50 million bushels of oats were converted to breakfast food. During the prewar period 1935–39, less than 29 million bushels on an average were used annually for the manufacture of breakfast foods.

The most common method of processing oats for cereal foods is by rolling. Oatmeal and rolled oats are obtained by these processes. Plump, heavy-weight oats are preferred for the manufacture of cereal foods. The oats are first cleaned and hulled. The oat grain is passed between rollers to produce rolled oats. Other breakfast foods are mostly composed of part oats and part other grains. These cereals are usually ground, then cooked and pressed into special shapes.

Utilization of Barley

Barley is also an important feed grain in the United States, but more than a quarter of the supply on an average is used for other purposes. During the war years about 70 percent of the barley crop was used for feed and seed, about 2 percent was processed for food, and 26½ percent for the manufacture of malt for use in the production of alcohol, alcoholic beverages, and other purposes. Only about 1 percent of the supply was exported. In the prewar years 1935–39 about the same percentages of barley were processed for food and industrial use as in the war years, but larger quantities were exported and correspondingly smaller quantities used for feed. Nearly 10 million bushels, or 4 percent of the supply, was exported annually on an average during that period, while 68 percent was used for feed and seed.

Barley is the principal grain used for the production of malt. Barley of a type and quality suitable for malting usually sells at a premium over other kinds. In the 10-year period ended 1946 only about one-fourth of the United States barley crop was classed as malting barley. In years when supplies of malting barley are short, other types less suitable for malting are sometimes used.

The malting of barley is done in three steps—steeping, germination, and kilning. The cleaned and sized barley is steeped in large cylindrical tanks to approximately 45 percent moisture. Two types of germinating equipment, compartments, and drums, are in general use in this country. The steeped grain is spread out on the perforated compartment floor or placed in rotating drums for germination. In both systems conditioned air at definite temperatures and high humidity is forced through the sprouting grain to control temperature and maintain moisture. The grain is stirred at frequent intervals to prevent matting of the developing rootlets and to aid in controlling

temperature. After 5 to 6 days the desired stage of germination is usually attained and the malt is conveyed to a two-floored kiln for drying. Preliminary drying at a relatively low temperature is done on the upper kiln, then the malt is dropped to the lower kiln, where it is finally dried at comparatively high temperatures. The germination and kilning conditions are different, depending upon the subsequent use of the malt. The dried malt is cleaned to remove rootlets, loose hulls, and dust and then placed in storage for a short or longer time, depending upon the use for which intended.

In normal times, approximately 75 percent of the barley malt produced goes into beer manufacture, 15 percent is used for the production of alcohol and distilled liquors, and 10 percent is used for the manufacture of sirups (including medicinal sirups) and other food. This latter list is extensive and includes malted milk and beverages and breakfast foods. Most uses of malt are based on the content of numerous enzymes or the flavor or both.

Use of Barley for Brewing

Brewing of a type probably predates distillation and is almost as old as civilization. In the United States other grains, usually corn or rice, are used with malt in the manufacture of beer. The former, termed adjuncts, constitute one-third, while malt makes up two-thirds of the grain constituents.

The adjunct with a small amount of the malt is mixed with water to make a mash, then boiled to liquify and gelatinize the starch. This is called the cooker mash. The main portion of malt is mashed in with water and held at a temperature optimum for the proteolytic enzymes to bring about some break-down of the proteins present. The cooker mash and malt mash are mixed at such a rate as to give the desired temperatures for conversion of the starch to fermentable sugars and nonfermentable dextrins by the diastatic enzymes of the malt. The proportions of these several compounds are controlled by temperatures and the time held at the temperatures during the mashing. The clear extract of malt and adjunct, called wort, is filtered off and run into a large brew kettle. Here it is boiled with hops to precipitate undesirable proteins, add the characteristic bitter flavor, and sterilize the wort. Brewer's yeast is then added to the clear cold wort, and fermentation allowed to proceed for 5 to 8 days at a low temperature. The yeast is separated from the beer and, after storing for aging and clarification, the beer is ready for filtration, carbonation, and placing into containers for distribution and consumption.

The residue of grains after filtering the wort is called brewer's grains and is used either wet or after drying for livestock feed. It is valued primarily for its protein content.

Pearl Barley

Most of the barley which goes directly into human food is consumed in the form of pot barley or pearl barley. About 1 million bushels of barley went into the production of these products annually prior to World War II. During the war period, up to about 5 million bushels of barley were used in the production of pearled barley. Barley flour and barley grits are products or byproducts of barley milling.

Pot and pearl barley are both manufactured by gradually removing the hull and outer portion of the barley kernel by abrasive action. To produce the highest quality of pot and pearl barley they must be made from barley which is free from discolored kernels and foreign material. Well-filled, high-grade barley of uniform quality is desired. Uniformity in kernel size is important because the finished product must be produced in definite sizes.

A common type of pearling machine consists of a cylindrical millstone, revolving rapidly within a perforated cylinder which runs more slowly in the opposite direction to the millstone. A sheet-iron casing encloses the revolving stone and perforated cylinder. The holes in the perforated cylinder are smaller than the grain, their purpose being to turn the grain over and over while the rapidly revolving millstone grinds off the hull. The machine operates on the batch principle. Valves in the spout which feed the pearler are operated by cams, so that a batch of about ¾ of a bushel is allowed to pass into the machine at fixed intervals. Each charge of grain is automatically held in the machine until the desired stage of milling is reached. Then a valve in the perforated cylinder opens and the pearled grain is discharged. The inlet and outlet valves are so timed that a fresh batch of grain is admitted just as the pearled grain is discharged.

After the grain is discharged from the pearler the mixture of offal and partly hulled barley is sent to a reel which removes the hulls. The barley is then aspirated to remove fine particles after which it is transferred to a cooling bin where the heat developed by the milling process is dissipated. This series of operations is repeated until a product of the desired size and purity is obtained. After the third pearling the bran is largely removed and at this stage the product may be classed and sold as pot barley. After five or six pearling operations, the resulting barley is small, round, and white. One hundred pounds of barley normally yields about 65 pounds of pot barley or 35 pounds of pearl barley.

In the manufacture of pearl barley some flour is produced as a byproduct. The pearl barley may be ground and sifted to produce a granular product, barley flour, and/or barley grits. When the flour is highly refined it is known as patent barley flour. Barley grits and less highly refined barley flour may also be made by rolling milling, bolting, and purification processes similar to those used in milling flour and wheat. The pearling process if carried to six pearlings results in the removal of about 74 percent of the protein, 85 percent of the fat, 97 percent of the fiber, and 88 percent of the mineral ingredients of the original barley, according to J. A. LeClerc and C. D. Garby, as cited by Geddes.[8]

Utilization of Grain in Production of Commercial Mixed Feeds

In recent years, particularly during the period of World War II, there has been a rapid expansion in production of commercial mixed feeds for use by poultrymen, dairymen, and livestock feeders. This

[8] GEDDES, W. F. TECHNOLOGY OF CEREAL GRAINS. The Chemistry and Technology of Food and Food Products, edited by Morris B. Jacobs. Vol. 2, ch. XV, p. 451. (Interscience Publishers, Inc.) New York, 1944.

industry uses large quantities of grain but statistics are not available as to the exact amounts. Reports on sales of commercial feeds by 20 States which have a tag or tonnage tax showed sales in these States of approximately 20 million tons in 1945. These sales compared with sales of slightly less than 10 million tons in these States 10 years earlier.

Practically all kinds of grains are used in the production of commercial feeds, but probably the use of corn exceeds that of any other grain. In some years, particularly when the supply is plentiful or other grains are scarce, considerable quanties of wheat are used in the manufacture of poultry feeds. Oats and grain sorghums are used regularly but not much rye goes into commercial feeds. The quantities of each kind of grain used varies with the price and the kind of feed produced.

Figure 47.—A modern warehouse where feeds are stored ready for shipment.

Most States require feed manufacturers to register the brands of feed that they wish to sell in each State. It is also necessary to guarantee the chemical analysis in respect to the fat, fiber, and protein content. This requires that the manufacturer maintain the quality of his feed within the limits of the guaranted analysis. This in turn limits to some extent the substitution of one grain for another. There is considerable room for substitution, however, because the various grains have similar feeding values. The feed manufacturer therefore utilizes, as fully as possible, those grains that from time to time are the cheapest and will result in the most economical production of feed. For this reason the use of the different grains in the production of commercial feeds varies from season to season.

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